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THE MANUFACTURE OF FIREWORKS IN FRANCE.

At all epochs of history, for centuries back, days of public rejoicing have been celebrated with fireworks. The sight of colored fires burning in the air and of pieces of fireworks set up on the ground has always served to excite popular enthusiasm.

On the occasion of the visit of the Russian sailors to Paris, this sort of spectacle was not forgotten. Magnificent fireworks were set off at the Trocadero on October 23, 1893. Fireworks of such importance have now become quite rare, and the Ruggieri establishment, which, since the one hundred and fifty or more years that it has been in existence, has undertaken the manufacture of the largest fireworks, regards these as one of the most important that have been seen in twenty-five years. So it has appeared to us of interest to follow the preparation and installation thereof, and this we are enabled to do through the obligingness of the heads of the house.

When we see those long trains of fire that afterward fall in many-colored stars rush into space, and when we are spectators of the combustion of those huge pieces representing palaces, vessels, and allegorical subjects, we generally have no suspicion of the way in which all this is done. So it is into the side scenes of the pyrotechnist that we wish to introduce the reader.

The establishment under consideration, which occupies an area of no less than 12,000 square meters, is situated on the road from Paris to Saint Denis. It will be understood that, aside from reasons of economy, there is also a question of prudence that carries with it the necessity of keeping remote from centers of habitation when substances as dangerous as those that form the basis of pyrotechny are handled. Special precautions are taken and each workman is isolated in a special shop, consisting of a shed constructed of very light materials, such as slabs of compressed cork and cardboard. Each of these sheds is separated from its neighbors by hurdles filled with earth (Fig. 1). In this way, if a disaster occurs, it is localized. Moreover, we must state that precautions of all kinds are so taken that accidents are becoming rarer and rarer.

The substances most employed in the manufacture of fireworks are, in the first place, saltpeter, sulphur, and charcoal, which, mixed in proportions that are not the same as ordinary powder, serve for the manufacture of rockets and fire sheaves. Chlorate of potash, the combustive *par excellence*, which, united with the salts of baryta, strontia, copper, etc., gives all the colors that were unknown to ancient pyrotechny, since the discovery of chlorate of potash by Berthollet dates only from the end of the last century. Gunpowder is also much employed by pyrotechnists for the firing of bombs and the manufacture of detonating pieces. They are obliged to purchase it from the government manufactories. The Ruggieri establishment consumes more than ten thousand kilogrammes of it a year.

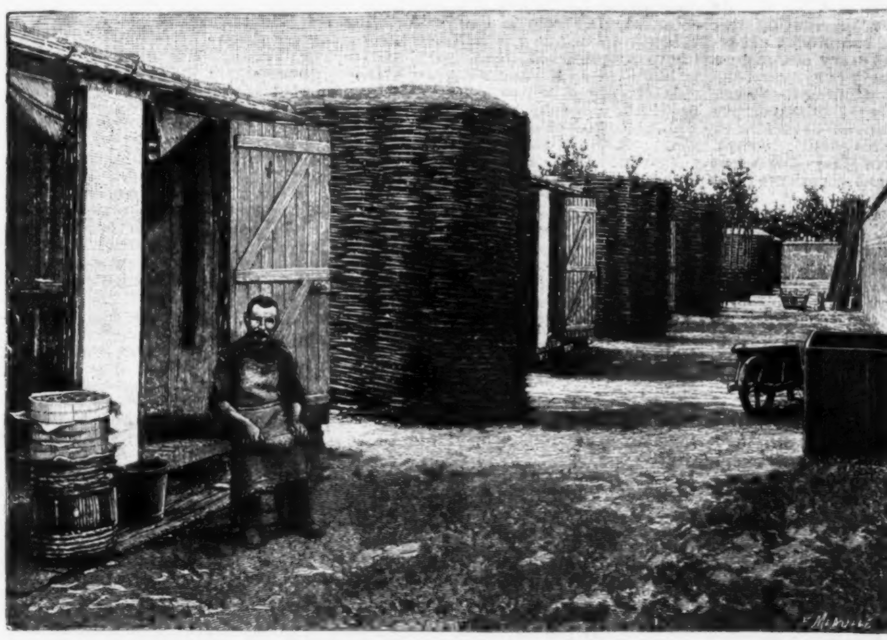


Fig. 1.—ISOLATED SHEDS FOR THE MANUFACTURE OF FIREWORKS.

We have no intention of entering into the details of the manufacture of each piece of fireworks. That would require a volume, and such a volume, very complete and very well written, already exists. To it we refer those of our readers who would like to have more details. As for us, we simply wish to give here a general idea of the principal pieces employed and of the preparations that the installation of large fireworks necessitate.

As sky rockets, sheaves of brilliant fire, bombs, and port fire constitute the basis of almost all fireworks, we shall pass the method of manufacturing them briefly in review.

The cardboard case designed to contain the composition of a rocket is most generally made of two or three sheets of paper of very good quality procured at a low price from dealers in old paper derived from commercial and other registers.

The cases thus manufactured are mounted upon cylindrical copper rods of the proper diameter and length. The extremity of the case is afterward choked either by means of a card or a special tool. The object of such choking is to present an obstacle to the exit of the gases produced by the combustion and thus to prolong their effect. In the Ruggieri establishment mechanical means are now employed as far as it is possible, and we shall revert to these further along when we come to the subject of charging the rockets. The cases especially are made of new paper on spools that a machine rolls into tubes of the dimensions required to form the rocket. The choking is replaced by a neck of refractory clay that assures a more regular flow of the gases. The cases thus obtained are lighter than the old ones and, consequently, less dangerous when they fall.

The sky rocket, which is also used for signals at sea and in war, is formed of one of these cases, in which the charge is arranged in such a way as to leave an empty space in the interior, called the bore of the rocket, and which occupies a large portion of the length. It suffices for this to arrange in the interior of the case a spindle, which is removed after the charging. This arrangement of the charge permits the composition to ignite over a wide surface at once, and the gas, escaping through the choked aperture of which we have spoken, produces the ascent. Above the charge, surrounding the bore, the composition is solid for a length of about one and one half times the diameter of the tube. In order to guide the rocket during its ascent and keep the choking through which the gas escapes at the lower part, there is adapted to it a long stick of light wood or osier that serves as a rudder, as it were. Although the rocket, as a whole, is not very heavy, yet, since it falls from a great height, it might prove dangerous to children, especially if it should strike them on the head; so it is indispensable to keep the spectators at a considerable distance from the place where it is set off.

The diameter of rockets varies from one centimeter to three and one-half centimeters. Above the mass is arranged in a tube of thin paper the heading, consisting of stars, rain of pearls, etc. It is the solid charge that communicates fire to the heading when the rocket is at the end of its travel. There are certain quite minute precautions to be observed in the arrangement of the solid charge in order that this effect may be produced exactly at the moment desired.

The charging of a rocket requires much care, and

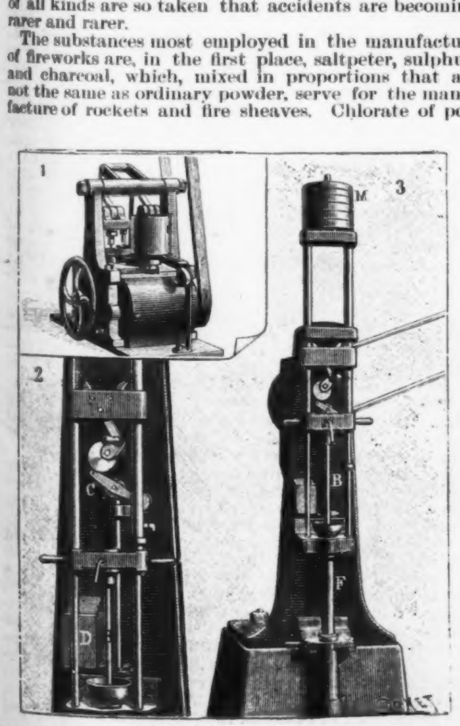


Fig. 2.—No. 1, MACHINE FOR COMPRESSING STARS. Nos. 2 and 3.—MACHINE FOR CHARGING ROCKETS.

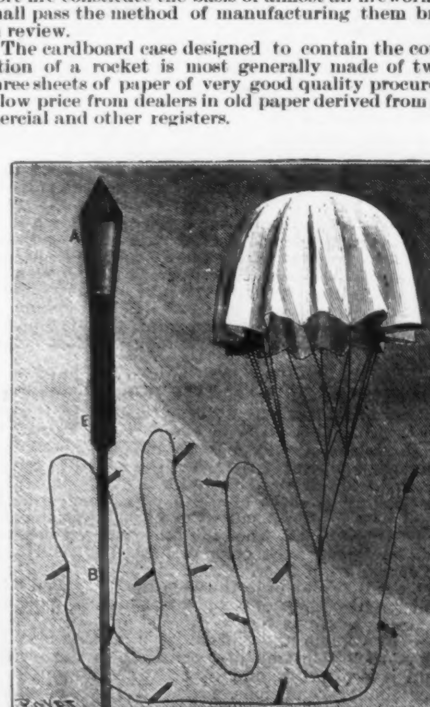


Fig. 3.—PARACHUTE ROCKET.

A, parachute folded; B, stick; E, rocket.

Fig. 4.

MORTAR AND BOMB.

the composition must be well rammed. There are rules that determine the weight of the mass to be employed and the minimum number of blows that it is necessary to give the rod for properly charging.

In the Ruggieri establishment, where a very large number of rockets are manufactured, a machine has been devised that does this work automatically (Fig. 2, Nos. 2 and 3).

The case, F, is secured to a spindle resting upon the foot of the machine. Above, there is a horizontal disk that revolves around a central axis. This is the distributer. It fills the cavities with which it is provided in passing under a receptacle, D, containing the composition, and empties them when it passes over a funnel arranged upon the rocket case. Between each of these charges a copper rod, B, surmounted by a leaden weight, M, effects the compression. A cam, C, allows it to fall a certain number of times, regulated in advance. The machine stops automatically when the charging is finished. A saving in time and manual labor is thus effected, and the work is more regular.

The headings of rockets often consist of many-colored stars. Some of these are manufactured from substances very dangerous to handle. The green stars, especially, composed of nitrate of baryta, sulphur, and chlorate of potash, require delicate manipulation. The other colors are generally less dangerous. The salts of strontia and copper and the sulphide of antimony enter into their composition.

The mixtures that form the stars are compressed under the form of small cylinders of sizes varying according to the dimensions and the height of the rocket's ascent. Here, again, a machine is used for the compression of the composition (Fig. 2, No. 1). As in the preceding machine, we find a distributing disk that takes the composition from a receptacle. It revolves with a jerking motion, and at every stoppage a spindle moved by an eccentric strongly compresses the composition. The disk afterward continuing its travel, the little cylinder thus formed finally reaches an empty space, where it falls into a box arranged to receive it. There is kept on hand a series of these small cylinders, that are all ready to form bouquets of stars of different colors designed for the heading that constitutes the upper part of the rocket.

Another arrangement merits also a few explanations. It consists in placing in a box situated above the solid charge a small parachute made of a thin fabric, and which separates from the rocket and unfolds when the latter has reached the end of its travel (Fig. 3). From this parachute there is suspended by a thread either a crown of stars that hovers over the spectators for quite a long time, or a string of small blue lights forming a sort of luminous *chenille* of a very curious effect.

A slow match, of course, is so arranged as to ignite these preparations only at the moment at which the parachute abandons the balloon. Our engraving gives an idea of the way in which things are arranged when it is desired to obtain *chenilles*. We may see here, too, the external form of a rocket, with its constriction, E (held below by the guiding stick, B), and its cone, A, which contains the parachute and heading.

When it is desired to send a very large number of stars into the air, there is employed a bomb, which is fired from an artillery mortar that, for prudence sake, is buried for three-quarters of its length in the earth.

This bomb consists of two hemispheres of cardboard united by means of numerous strips of paper. It is filled with the chosen packing (in most cases of colored stars), and there is arranged in it the quick match, a small fuse designed to communicate fire to the contents at the moment that the bomb reaches the end of its travel. In order to render it unnecessary to bother every time with the charging of the mortar designed to fire the bomb, there is fixed to the latter, by means of a paper case, the quantity of powder necessary to cause it to ascend. This is what is called the *chasse*. A long slow-match that winds around the bomb and joins the *chasse* protrudes from the mortar after the introduction of the bomb, and serves to ignite the latter (Fig. 4).—*La Nature*.

ADULTERATED LINSEED OIL.*

THE pernicious system of adulterating oil, carried on by the jobber, and in some cases by the small Western crusher, was, unfortunately, never so prevalent as at the present time. It is this condition of affairs which fosters suspicion and distrust in the minds of certain consumers, who at some period or other have made the mistake of buying a cheap oil, and having found it badly adulterated, declare that to procure a really pure article is one of the most difficult tasks possible. Their objections are frequently based on unjustifiable grounds, as shown by the following incident, which came under the writer's personal observation.

A cask of kettle-boiled oil was shipped to an old consumer, one whose experience would have been considered of sufficient value to warrant the expectation of a correct mode of procedure when testing the quality of an oil. Within a period of a few days the cask of oil was returned, with the statement that it was badly prepared or something worse (here an insinuation was intended to be conveyed that it was adulterated), that it was so inferior in quality that its use was out of the question, and a request to forward an equivalent quantity of genuine oil. Knowing the utter uselessness of entering into a controversy with this man, and that the emphatic statement that the oil was exactly similar to that in stock at the factory, and that all the oil was similarly treated—knowing that these statements would fall on doubting ears, the rejected cask of oil was emptied, its contents placed in other packages, and the same oil was immediately forwarded to the fault finder, and developments were quietly awaited. In two or three days the information was received that the last consignment of oil shipped gave entire satisfaction, there being as much difference between the oil last received and the rejected article as there is between chalk and cheese; coupled with the advice for the future to be more careful and to forward nothing but good oil! Comment on this is needless, but it may be supplemented by stating that the above is not by any means an isolated case.

Boiled oil is frequently adulterated with resin, colophony, cottonseed oil, fish oil, etc. Some oil boilers who purchase the crude oil from the crusher to be treated by themselves, and not infrequently the small crusher, also, place in the boiling kettle one-eighth of the weight of the oil treated of resin oil, ostensibly to increase the hardening properties of the oil, but really to insure a very large profit, altogether out of proportion to the current market value of the commodity. When the turpentine market is sufficiently low, the jobber or middleman (and the writer has recollection of instances where crushers west of Chicago were known to be guilty of similar procedure) will place several barrels of boiled oil along the floor, bung up, and pump from each about one-half gallon of the boiled oil, to be replaced by oil of turpentine, the whole being shipped as a pure boiled oil. The admixture of oil of turpentine with the oil doubtless promotes its drying qualities, but the objection lies in the fact that the article is placed on the market as a pure linseed oil. . . .

By boiling say twenty pounds of oil from a parcel for several hours at the highest safe temperature, being careful at the same time to preserve a uniform temperature, the practical varnish maker can ascertain whether he has properly prepared oil to deal with, whether it will be economical or otherwise; while at the same time its action under manipulation will prove a trustworthy guide when putting the main parcel under treatment afterward. Any peculiarity in the smaller lot—for instance, a tendency to rise or swell in the kettle—would be observed and especially guarded against in the larger lot. The test of a good varnish oil consists, in this case, in its not losing more than 10 per cent. of its original weight in vapors, destructive distillation, etc., and in its retaining a good color, varying from a light color when the operation is begun to a hue gradually deepening and brightening to the peroid of its completion, when the product is changed to a rubber-like substance. So strong is this oil rubber, which is formed by the continuous application of heat at a high temperature (about 550° Fah.), that should a fair sized animal, say a good, strong cat, be unfortunate enough to be placed in the substance when sufficiently cold, it would be utterly unable to extricate itself, notwithstanding the most violent efforts which such an animal can usually exert in such an emergency. The elasticity of this product when drawn out in long strings and its sudden backward spring when released is surprising to the uninitiated. This substance is used in the manufacture of surgical instruments. Some manufacturers of rubber goods make a varnish of the oil alone, boiled to the proper consistency without the aid of nitric acid, while others use gums and various chemicals.

While treating on the subject of oil rubber or caoutchouc, as it is sometimes called, it may be well to observe that no better test for a good quality of oil than the above mentioned method need be applied. Of course, its tediousness and the danger incurred during the operation prohibit its adoption as a regular test for all the purposes for which linseed oil is used, but in the manufacture of linoleum an exception might well be made. After the oil treated has had sufficient time to cool, if it becomes solid without the presence of a sticky or greasy substance, it is undoubtedly pure; but if it should remain sticky and partly fluid, it can be looked upon as an adulterated article.

A convenient form for testing a boiled oil is to cover lightly the surface of a small piece of glass, and place the glass standing on edge against the wall. Should it dry in from six to eight hours without being "tacky" when the finger is applied, it may be pronounced a fairly good boiled oil; but, of course, this refers to its drying properties only. Allowance must be made on occasions for varying atmospheric conditions.

Very many methods have been devised by means of which an adulterated oil may be detected. As the specific gravity of linseed oil is lower than that of any of its usual adulterants, it is frequently detected by ascertaining the gravity of the suspected sample. However, in order the more effectually to disguise the adulteration, recourse is sometimes had to a lighter grade of inferior oil, which is so blended with the heavier kind that detection by this means is difficult unless a very careful analysis and specific gravity test are given. The purity of a sample of oil suspected of containing fish oil may be readily ascertained by the application of heat, which, if the sample be impure, will evolve the unmistakable fishy odor characteristic of menhaden and other fish oils.

The most trustworthy test that can be applied to a sample suspected of containing cottonseed oil is based on the well known propensity of the latter to change to a thick, whitish substance when placed in a low atmosphere—a refrigerator or a freezing mixture, for instance. By placing two samples, one known to be pure linseed oil, the other the suspected one, in a good refrigerator or in a freezing mixture, the latter, if adulterated, will thicken as above described, while the pure sample, although thickened to a slight extent, will be found to have retained its color, this striking contrast constituting the test.

A general method of detecting an impure oil, as practiced in German laboratories, consists in the application of concentrated sulphuric acid in the proportion of one part to one or two parts of the oil. On this admixture a very intense action immediately ensues, the temperature rises and the mixture becomes colored. A few drops of the oil are placed on a glass plate having a sheet of white paper beneath. To the oil is added a small drop of sulphuric acid of specific gravity 1·632, when the oil becomes thick and the characteristic dark color of linseed oil will be at once developed, if pure.

The peculiar and objectionable quality called "fattening" which is sometimes present in linseed oil, and which on occasions has a decided propensity to increase in volume and diffuse itself throughout the body of the oil, instead of separating, as the settling period is prolonged, and as all other impurities do under similar conditions, proves a source of annoyance to the consumer. The result is directly traceable to the use of a seed which contains a large proportion of foreign oleaginous matter, such as mustard seed, rape seed, etc., the oil from which, being of a non-drying and viscous or fatty nature, is pressed out with the oil from the linseed by the great hydraulic machine, commingling with and imparting to the latter oil its objectionable properties, thus producing a very inferior article. Where seed is thoroughly screened before being put into the mill hoppers the presence of such foreign seeds or impurities of any kind to an extent sufficient to affect the quality of the oil deleteriously is practically impossible. Therefore, the sure way to guard against such an inferior product is to take the precautionary measure of cleansing the seed. The specific gravity of the non-drying fatty oil being less than that of linseed oil, decantation after a period of repose is of no avail. However, it sometimes occurs that a paint manufacturer is mistaken in applying this title of "fattening" to an oil, the fault resting with his improper manipulation of the pigments and oil during the mixing process. The writer remembers an instance where a vigorous complaint was made by a consumer who purchased one barrel of oil that was drawn from a tank which contained 50,000 gallons, and who positively asserted that it was unfit for use from its undoubted fattening properties; this, notwithstanding the fact that every gallon of the 50,000 had been delivered to various consumers without another solitary complaint.

Oil of this nature is of far less frequent occurrence in this country than in England. In very many instances the superior quality of the oil is not the objective point of the manufacturing process in England.

The great bulk of the seed used in that country is imported from the East Indies, chiefly Calcutta; the seed from the vast territory surrounding the latter city contains on an average 15 per cent. of impurities, a large proportion of the latter being foreign oleaginous matter, such as mustard and rape seed, etc. The manufactured product of such a combination is in every instance an oil possessing "fattening" qualities. The writer has seen many thousands of bushels of seed worked in this manner without any preliminary screening process, in London. The American crusher (at least in the great cities) is much more careful in the preliminary processes necessary to procure a pure oil than the members of the craft across the ocean.

This article would be incomplete without a reference to the quality of oil called "pale boiled." This oil is extensively used; it is free from litharge or lead compounds of any nature, its treatment being more mechanical than chemical, and a light color, as its name implies, being aimed at, it is not subjected to a high temperature. A large proportion of the oil which comes under this heading is accorded very little treatment, the whole operation in many cases consisting of pouring into the barrel of crude oil some worthless compound, and thus completing the operation—whence the term "bung boiled."

Oils boiled with leads, having a deep hue, are unsuitable for special work, sometimes affecting the purity of the white lead, zinc white and delicate tints. Where delicate tints are a leading feature, as in decorative house painting, genuine pale boiled oil is advantageously employed.

A peculiar propensity of linseed oil is its tendency to increase in weight when exposed to the air in a vessel protected from dust. So far as its physical qualities are concerned it undergoes a gradual change, assumes a darker color, becomes more viscous and less inflammable. An experiment made by a Bavarian chemist resulted in 3·5 oz. of pure linseed oil increasing 0·31 oz. in weight after the oil had been exposed to the air eighteen months, an increase of about 8 per cent.

* From *Drugs, Oils and Paints*.

METHOD OF MAKING STANDARD SPERM CANDLES.

THE metropolitan gas referees have lately issued the following particulars concerning the methods to be adopted in manufacturing standard sperm candles for photometric work:

(1.) All candles to be used in the testing places shall be made with the materials hereinafter prescribed, and shall, when made, be examined and certified by the gas referees.

(2.) The wicks shall be made of three strands of cotton plaited together, each strand consisting of 18 threads. The strands shall be plaited with such closeness that, when the wick is laid upon a rule and extended by a pull just sufficient to straighten it, the number of plaits in four inches shall not exceed 34 nor fall short of 32. Each wick shall be of suitable length and looped ready for fixing in the mould. After having been bleached in the usual manner and thoroughly washed, the wicks shall be steeped in a liquid made by dissolving one ounce of crystallized boracic acid in a gallon of distilled water, and adding two ounces of liquid ammonia. They are then to be gently wrung or pressed till most of the liquid has been removed, and dried at a moderate heat. Twelve inches of wick thus made and treated shall weigh not more than 6·5 nor less than 6 grains. The weight of the ash remaining after the burning of ten wicks which have not been steeped in boracic acid, or from which the boracic acid has been washed out, shall be not more than 0·025 grain. Wicks made in accordance with this prescription shall be sent to the office of the gas referees, by whom they will be examined and certified. The wicks so certified are to be used by the candlemaker in the condition in which they are returned to him.

(3.) The spermaceti of which the candles are made shall be genuine spermaceti, extracted in the United Kingdom from crude sperm oil, the product of the sperm whale (*Physeter macrocephalus*). It shall be so refined as to have a melting point lying between 112° and 115° F. An account of the method by which the melting point of the spermaceti is to be determined is given in the appendix. Since candles made with spermaceti alone are brittle, and the cup which they form in burning has an uneven edge, it is necessary to add a small proportion of beeswax or paraffin to remedy these defects. We, therefore, prescribe that the best air-bleached beeswax, melting at or about 144° F., and no other material, shall be used for this purpose, and that the proportion of beeswax to spermaceti shall be not less than 3 per cent. nor more than 4½ per cent.

(4.) The candles made with the materials above prescribed shall each weigh, as nearly as may be, one-sixth of a pound, and will be found to answer to the follow-

ing test: Immerse a candle, taper end downward, in water of 60° F., with a brass weight of 40 grains attached to the wick by a small piece of thread. When a further weight of two grains is laid on the butt end of the candle, it will still float; but with a weight of 4 grains it will sink. As the rate of burning of a candle is affected by the force with which the wick is pulled when it is set in the mould, the strain commonly applied by an experienced maker of candles has been measured, and is found to be about 24 ounces. The candles shall be sent to the office of the gas referees, by whom samples from each batch will be examined and tested. Each batch of candles shall be accompanied by a specimen of the spermaceti (unmixed with beeswax) which was used in making them. Packets of candles approved by the gas referees will be sealed by them and certified for use in the testing places.

(5.) The candles are to be used by the gas examiners as heretofore, in accordance with the half yearly "notifications" of the gas referees. The results are to be corrected, as usual, on the assumption that for small variations the light of a candle varies directly with its consumption; and if any candle in a packet certified by the gas referees is found by a gas examiner to burn at a rate exceeding 126, or falling short of 114 grains per hour, the testings made with that candle are to be rejected.

METHOD OF DETERMINING THE MELTING POINT OF THE SPERMACETI.

As various methods are used by different refiners of spermaceti for determining the melting point, which lead to different results, it must be noted that the temperatures here given as the limits within which the melting point of a sample of refined spermaceti should fall, viz., 112° to 115° F., have been found by the following method, which is known as the capillary tube method:

A small portion of the spermaceti is melted by being placed in a short test tube, the lower end of which is then plunged in hot water. A glass tube, drawn out at one end into a capillary tube about 1 mm. in diameter, is dipped, narrow end downward, into the liquid spermaceti, so that, when the tube is withdrawn, 2 or 3 mm. of its length are filled with spermaceti, which immediately solidifies. The corresponding part of the exterior of the tube is also coated with spermaceti, which must be removed. The narrow part of the tube is then immersed in a large vessel of water of a temperature not exceeding 100° F. The lower end of the tube which contains the spermaceti should be 3 or 4 inches below the surface and close to the bulb of a thermometer. The upper end of the tube must be above the surface, and the interior of the tube must contain no water. The water is then slowly heated, being at the same time briskly stirred, so that the temperature of the whole mass is as uniform as possible. When the plug of spermaceti in the tube melts, it will be forced up the tube by the pressure of the water. The temperature at the moment when this movement is observed is the melting point.

METHOD OF WASHING WICKS.

As it is found to conduce to the regular burning of candles that the wicks should have been, as far as possible, cleaned and freed from mineral matters, it is recommended that the candlemaker, before steeping the wicks, shall wash them first in distilled water made alkaline with between one and two per cent. of strong liquid ammonia, then in dilute nitric acid containing about ten per cent. of strong acid and then repeatedly in distilled water.

HOW TO MAKE STATUARY IN PAPER.

A NEW branch in the art of home adornment, which is well worthy of attention, has been wrought by Mrs. Cordelia Shout, of Pittsburg, Crawford Co., Kansas. Our notice was first called to the work of this artist by Mrs. A. N. Leigh, of the same place, who sent us a photograph of the originals from which our engraving has been produced. The principal example is a graceful statue of a female figure, made of paper, and there are also vases and chairs. Our engraving hardly does justice to the statue, which is quite an artistic production. As all these specimens are of home manufacture, we have thought it would be interesting to our readers to learn from the author herself how they were made, and we accordingly give the following account, which Mrs. Shout has kindly furnished to us:

"You will see by the photograph that the principal piece of work is a statue, the title of which is 'Surprised at the Bath.' The expression is intended to be one of displeasure. It is five feet high, weighs ninety pounds, is made of waste wrapping paper and flour paste, and finished with several coats of white lead.

"There are three vases and two chairs made of paper, which have been in use for nearly a year, and have not suffered from use.

"The statue is solid. There is a wire frame for the limbs and head. I wound it with stout cloth strings, wet in flour paste, let it dry until firm enough to stand. Then I put on the paper until it was the desired shape and size, always letting it dry after going over it with two or three thicknesses of paper wet with paste and well pressed down with my hands. When I get too much on in one place, I whittle it off when dry. Of course, the more nearly correct it is made in the first place, the less work there will be to make corrections.

"Taking everything in consideration, I think paper is the best material for working out one's ideas in art or ornament that has ever come in use, because every one can get the material, and if we fail or make a mistake, or wish to change, we can do so without losing all of the work. After I had the statue nearly done, I changed it by sawing the neck and waist in to the wire, then turned and bent in the shape desired, cut out some wedge-shaped pieces of paper, and pasted them in the cavity until it was all solid and firm as ever.

"The chairs have wire frames tied where the wires cross, with strings wet with paste, then filled and pressed in between with paper till even with the wire, and as much more as desired. Pieces of stout cloth are good where increased strength is required, always finishing with paper. The paper can be rasped to make it straight. Sandpaper and oil paint make a good finish

"The vases are made by cutting paper and sawing or pasting it in shape. It is best not to put too much paper on at once, but dry often.

"I commenced the statue in June, 1886, and had it ready for the fair in October. It might take longer to make one in marble. In paper we can try as often as we please to improve the expression. Marble may always be considered the best in art, but paper has a great many advantages. It can be knocked about with little care, and if broken can be repaired. I executed this work and hardly missed the room it took in the house. It is light and easily carried and stowed

away anywhere, when I had other work to do. I never would have had a chance to do in marble what I have and can do with paper, and that may be the case with many others.

"I send three sketches; the heavy lines, five in number, in the statue represent the length of the wires. They can be bent any shape to suit. It is easier to make the hands and ears separate, then fasten in and finish afterward. The feet must be made solid at first, or they will not bear the weight if moved while damp with new paste.

"The crosses in the chair show where the wires are tied with pasted strings. Then paste on and fit in as stated before.

"A cone-shaped paper is all that is necessary for a straight vase; for a very slim stem, a wire frame will make it so stout there will be no danger of breaking."

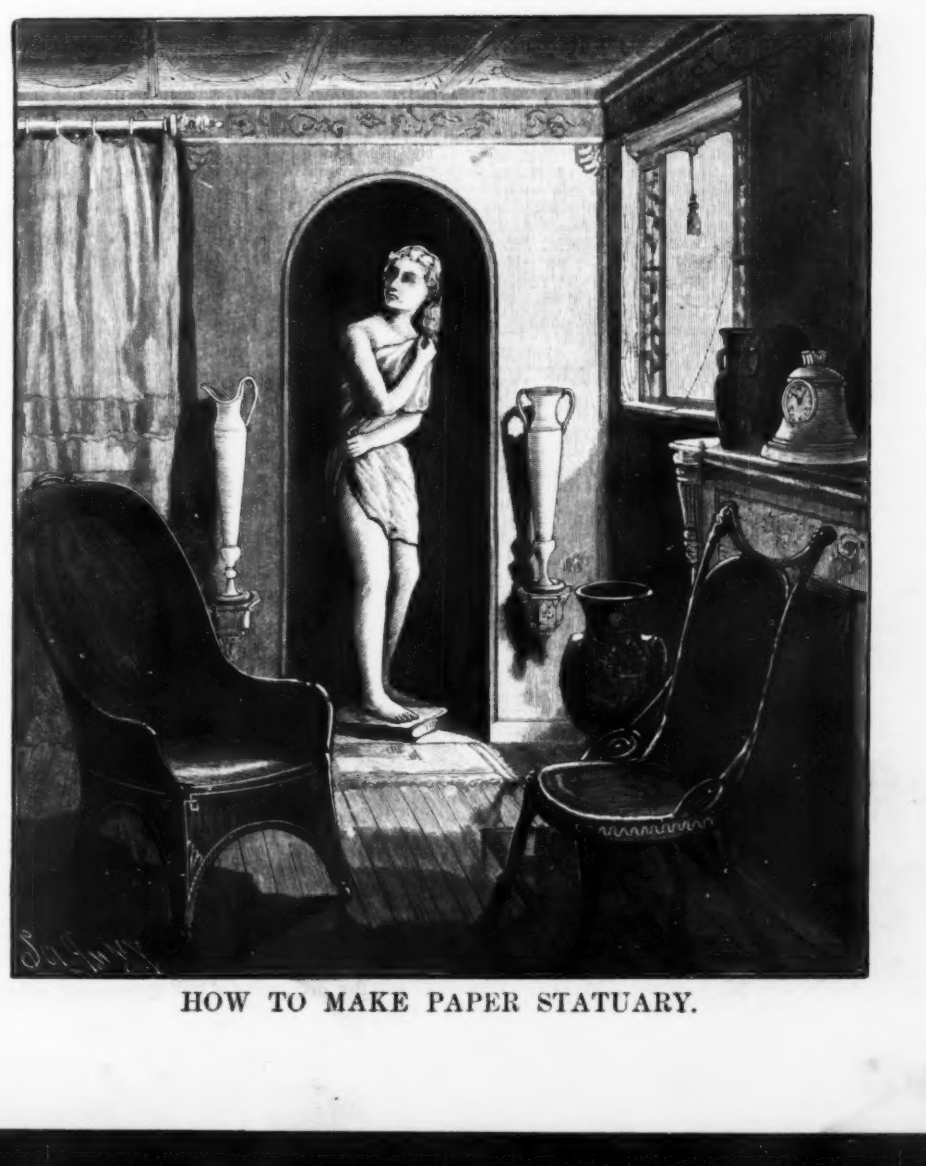
CARRIAGEWAY PAVEMENTS.

UNLIKE many technical questions, the construction of our roadways is of direct interest to every one, whether engineer or street arab, though what particular class of pavement is most in favor with the latter no one has yet thought it worth while to inquire.

As for the small boy, sufficiently high in the social scale to rejoice in the possession of a pair of roller skates or a bicycle, there is no doubt that his vote would be given in favor of asphalt. As yet, however, no party has risen in the state to claim for this class a voice in municipal matters, and his likes and dislikes may therefore be disregarded. It is hard to say what the earliest pavements may have been made of, whether of wood or stone. Certainly, if one judged by the vestiges of old-world civilization yet remaining, it would be natural to conclude that the use of wood as a paving material was unknown to the ancients. Nevertheless, it is not at all unlikely that the first attempt at a pavement was the laying of logs side by side to form a corduroy road, in the manner still common in the wooded districts of our colonies and of parts of the United States.

This is, of course, a very different method of using wood from that practiced in modern cities, where the real pavement is the concrete foundation, the wooden blocks merely constituting a wearing surface. In fact, in most good modern pavements, whether in macadam, wood or asphalt, the real pavement is the foundation, on which is laid a more or less easily renewable covering taking the wear.

Set pavements are, however, an exception, the blocks being frequently laid on a thin layer of sand or furnace ashes. The art of constructing a good pavement was thoroughly understood by the Romans, some of whose pavements are still in use in Italy. It is remarkable how long a time elapsed before decent pavements began to be laid in England. It is well known that our ancestors can scarcely be said to have enjoy-



HOW TO MAKE PAPER STATUARY.

ed (?) the possession of a nervous system, but if additional proof were required, it is afforded by their long and apparently uncomplaining endurance of the torture of the cobble-stone pavement. As Sir Benjamin Baker reminded the meeting at which Mr. Isaacs' excellent paper on the subject was read at the Society of Arts, it was in 1762 only that the first granite set pavement was laid in London, the old pavement being cobble stones. Of course the traffic was nothing like the present in amount, but even a single light trap driven at a high speed past one's windows over cobbles is quite sufficient to interrupt conversation for the time being.

Possibly this fact may account for the taciturnity so commonly attributed to Englishmen in those days and which certainly has diminished of late years, though it would, perhaps, be going too far to credit this possibly questionable improvement to the great advance which has been made in the art of paving during the past century.

The benefits of a good pavement are of a somewhat indirect nature. The average man, no doubt, sees that horse and vehicle owners do gain an advantage in the lessened traction; but his own interests, save in the matter of noise, do not appear so directly, as the decrease in the cost of goods, owing to their more easy and rapid handling, only makes itself felt comparatively slowly. There is thus, particularly in new countries, a disposition to economize in the matter of paving. Something, however, can be said in defense of this.

Towns in new countries are practically invariably laid out with excessively wide streets, the satisfactory paving of which is far beyond the resources of the young community. It would be far better in such cases to pave only a portion of the road thoroughly, in place of, as is so often done, to pave the whole of it in an indifferent manner.

There is a consensus of opinion that granite sets, properly laid, make the cheapest pavement of any. It is also comparatively hygienic, and no system is so well adapted to the laying of that modern abomination, the tram rail, which, however useful and necessary it may be in providing a cheap, if somewhat slow, means of communication between a city and its suburbs, should find no place in the heart of the city, in the crowded streets of which the cars still further obstruct the already congested traffic. Where, however, tram lines are to be laid, there is no doubt that it is easier to maintain the surface of a stone pavement than any other. Its principal disadvantage is its noise, but it is also liable to become slippery by wear, and in Continental cities there is another objection to it, viz., the splendid material it affords for the construction of barricades.

No act of Napoleon III. showed greater astuteness than the laying of the Paris streets with asphalt, which may claim the credit of being, of all paving materials, that least adapted to the requirements of the rioter. Since the inauguration of the republic, wood seems to have been more or less replacing asphalt in the Paris streets; and in spite of the many serious objections to it, it has apparently become the favorite material in London. Its only advantages seem to be that it is the least noisy of all pavements, and that, though very slippery, a horse when he falls can rise comparatively easily, and is not so likely to be injured. From a pedestrian's point of view it is only less objectionable than granite, because of the noisiness of the latter. In dry weather it stinks, and in wet weather it becomes covered with a liquid filth, which, by passing vehicles, is sure to get splashed into the face and over the clothes of the unfortunate pedestrian, unless the footpath happens to be wide and he is able to hug the house line pretty closely. When in good condition, the traction on it is no doubt low, but it is difficult to believe, when in the state into which it is sometimes allowed to get, that it has then any advantage over granite. It requires renewing at shorter intervals than either granite or asphalt. Indeed, where the traffic is very heavy, six or seven years seem the limit of life, though in more favorable conditions this may be extended to ten. Under average conditions the Improved Wood Company claim a life of nine years. The renewal of the pavement in an important thoroughfare is a serious matter, causing great annoyance and obstruction of business, and, other things being equal, the longest-lived pavements should invariably be chosen. Unfortunately other things are not equal, and as there is not the slightest likelihood of a general adoption of rubber tires for vehicles, it is probable that wooden pavement will be greatly extended within the next few years.

Apart from its slipperiness and cost, asphalt makes an ideal pavement. It is somewhat more noisy than well-laid wood pavement in good condition, but the noise is both less in amount and more agreeable in character than that of set pavements. Indeed, on asphalt the noise is mainly due to the beat of the horses' feet, and has sometimes an almost musical ring; further, there is a complete absence of the nerve-tearing rattle due to the bumping of a heavy wagon from one set to another, or in and out of the holes which soon form in badly maintained pavements of both wood and stone. Such holes certainly form in asphalt, too, but there is no pavement in which they can be so easily and so efficiently repaired. From a hygienic point of view, it stands far in front of all competitors, its absolute imperviousness affording no permanent lodgment for filth, and no pavement can be so easily cleansed. As regards its slipperiness, this can be greatly diminished by proper attention. In Berlin, Mr. Isaacs informed us, it is the favorite pavement, and is not found to be specially unsafe for horses. Berlin, it must be remembered, has a much severer winter than we have, and hence it should be more difficult to render it safe for horses than it is here. The secret of the success attained is to be found in keeping the asphalt perfectly clean. Clean asphalt is not slippery either wet or dry, but every one knows how commonly horses fall on it in London when rendered greasy by a shower. In Berlin the asphalt is thoroughly washed every morning, and, should a good shower of rain fall during the day, the cleaning gangs reassemble and wash it again.

Naturally, with the narrow streets so common in the City of London, there is a much greater concentration of the filth in the roadway, but there is no doubt whatever that better results could be obtained if sufficient pressure were put upon the authorities. Our experiences in this country have been almost confined to natural asphalt, the artificial ones not being in favor, owing to the belief that in crossing a street paved with them in hot weather the pedestrian is likely to leave his boots behind him on the way. The earlier attempts at artificial asphalts were certainly open to this objection, but the difficulties appear to have been overcome in America, where the Barber Asphalt Company have laid some six and a half million square yards during the past fifteen years.

Of other forms of pavement, macadam is, no doubt, the safest of any, so far as horses are concerned. It is, however, extremely dirty in wet weather, and excessively costly to maintain, if the traffic over it is at all dense. In short, macadam has no business in the streets of a large city, and why it is still used along the Thames Embankment is a mystery to which we do not possess the key. In the United States brick pavements have been largely laid during the past few years, with, it is claimed, very satisfactory results. The bricks in question are of a special type, having great density, hardness and strength. Many of the bricks used have an average crushing strength of 450 tons per square foot, or about the same as Staffordshire "blues," and special samples have, it is stated, only failed under three times this stress, or upward of 1,300 tons per square foot—*i. e.*, superior to many granites. Of course the crushing strength of a stone is in itself but an indifferent criterion of its merits as a paving material, but it is certainly one element of importance, and the bricks in question are claimed to wear well under traffic.—*Engineering.*

THE VALERE RUNNING MACHINE.

AT the coming International Exposition of Velocipedy at Paris there will be exhibited a machine of a very peculiar model, the bicycle of Mr. Valere, a Frenchman. Up till then the invention will be kept somewhat in the shade by Mr. Valere, but despite the precautions taken, the indiscreet are nevertheless already anticipating a great renown for it.

There is one fact that puts the curious on the *qui vive:* A month ago, Mr. Valere, starting out upon his bicycle for the eighth time only, and meeting in the Bois de Boulogne the racer Farman, the 100 kilometer champion of France of 1892, challenged him to a trial of speed to be made at once. The matter was immediately arranged, and the race was begun. Upon a stretch of 300 meters, Farman was distanced by three lengths. He stopped with lungs exhausted through the spiritedness of the running. The news, immediately disseminated through the journals devoted to bicycling, was verified, and recognized as true. Was it the announcement of a revolution?

The Valere machine is of almost ingenuous conception. It adds, upon a simple bicycle, the work that the arms are capable of furnishing to that which the legs furnish. The arms aid the legs in their rotary motion. That is all.

But the originality of the system does not reside in this. A great number of inventors have conceived the idea of utilizing the arms in bicycling, either as the principal motor or an adjunct one. In Germany alone there exist more than two hundred patents relating to this question. The originality of the Valere system consists in the very ingenious mode of application of these two species of motors to the same toothed wheel. The one who rides upon this machine executes natural motions only—*those of a man in the act of running*, hence the name bestowed upon the apparatus, the "running machine."

Mr. Valere, who is a painter in enamel of great merit, is likewise a celebrated oarsman who at intervals has already won more than eighty first prizes in boat races. When he for the first time made the acquaintance of a simple bicycle, in July, 1892, he, who was accustomed to the hard work of the arms that the oar and paddle required, was surprised to see the inaction that, in bicycling, is inflicted upon our upper limbs, which are nevertheless so vigorous. He immediately conceived the idea of a machine that should utilize these slighted limbs and endeavored before all else to construct a rational apparatus, that is to say, one that should not counteract the natural motions of a man in the act of walking. He took for his model the foot race with an ambling motion, suggested by figures on Greek vases. If such motions of the ancient athletes be roughly analyzed, we find that, when the right leg is moved forward, the right arm immediately moves with it in the same direction, while the left leg and arm remain behind, and reciprocally. What is done in the Valere machine? The right leg bearing upon the pedal, the right arm pushes the right hand lever, while the pedal to the left, that is to say, the left leg, rises behind and the left arm pulls the lever to the left toward the body, and reciprocally.

FIG. 1.—THE VALERE RUNNING MACHINE.

The motions that this apparatus requires are therefore natural—*instinctive* even. This is the important point that distinguishes the Valere patent from former patents treating of an analogous question, and that decides in its favor. It is herein especially that resides the value of the invention.

Mr. Valere in the first place constructed a tricycle whose weight, certainly 36 kilogrammes, in no wise approached that of our ordinary three-wheeled machines, which often weigh but 16. Nevertheless, upon this heavy apparatus, without any practice on the track and without any training, and despite a very legitimate apprehension of the sloping curves that he met with for the first time, and in consequence of a fatal retardation of speed at these difficult points, Mr. Valere made, upon his first visit to it, the round of the Seine Velodrome (500 meters) in 45 seconds. The distance made by the apparatus at every complete revolution of the pedal was 7 meters, while our tricycles make scarcely more than 5·25.

The Valere tricycle is the machine that many inquisitive people have already seen, and that some have even ridden by way of trial; but the bicycle has as yet been exhibited to but a very small number of amateurs upon remote roads, and has not yet been described.

FIG. 2.—DIAGRAM OF THE VALERE MACHINE.

A B C and A' B' C', levers; C P and C' P', connecting rods; M and M', pedals mounted upon the cranks, M P and M' P'.

We shall here give an explanation of it in a few lines that are unfortunately incomplete and necessarily somewhat dry.

The running machine has the aspect of an ordinary bicycle. Its frame, however, is more elongated. Upon the lower tube of this frame that connects the head with the crank arms are mounted two levers, A B C and A' B' C', formed of tubes strengthened by tension rods, S. The joint is situated at the point, B. These levers act upon the sprocket wheel through small connecting rods, C P and C' P'. There are, therefore, joints at these four points.

The pedals, M and M', are mounted upon cranks, M P and M' P', which are not, as usual, keyed to the center of the sprocket wheel at O, but at P and P', that is to say, at the points worked by the levers. But, since the angle, M P O, is constant, this arrangement, necessitated by the exigencies of the construction, is equivalent to a crank of the length, M O. How is the steering done? The steering gear, most certainly, is not the most commendable part of the machine, and Mr. Valere finds no difficulty in acknowledging the fact. We briefly indicate, transferred to the bicycle, the steering gear that the inventor has applied to his tricycle, but which he will have changed in a month for the Exposition. It is here merely a diagram.

The steering is done by means of racks that cause the ascent or descent along the levers of two sliding boxes, into which are inserted the extremities of a horizontal lever, the profile of which is seen at I. Upon the center of this lever is brazed at right angles a second lever, which, at L, controls, in a slide, the steering bar brazed at K, upon the head of the machine.

It will be seen, then, that upon turning the handles of the levers, the rider causes, for example, the ascent of the slidebox, which takes in the extremity, I, of the horizontal lever, and consequently raises this point, I, causes the second vertical lever to incline to the right, and thus causes the steering wheel to turn to the left.

All this is certainly complicated, and the best of our present bicyclists would have to take three or four lessons of an hour's length before feeling somewhat at ease upon this machine. But Mr. Valere's remarkable invention is not impaired by this detail, which is important, but not fundamental, and which the manufacturers will be able to improve.

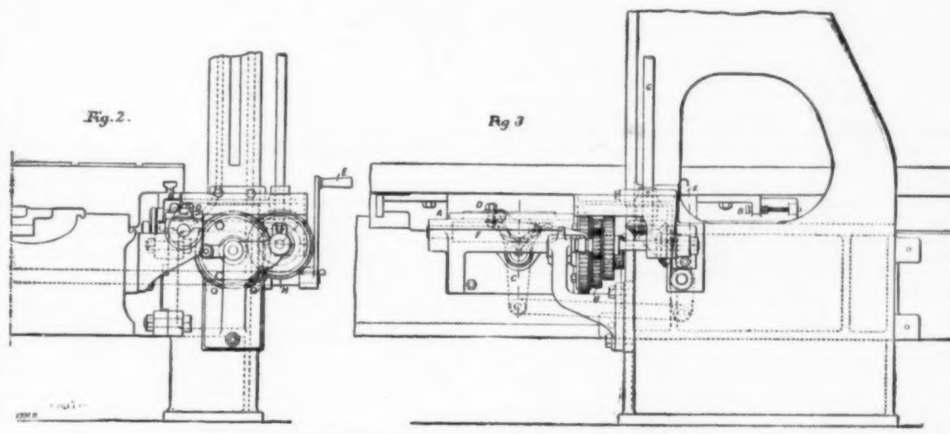
What results have been given up to the present by the running machine? Very good, but yet incomplete ones. The Valere tricycle, ridden by the inventor himself, has beaten all the racers in Germany who have competed with it. In France it has conquered several fine wheels. But, in order to be exact, it must be acknowledged that no very regular test has as yet been made. Mr. Valere has always ridden his machines himself, and he is not a racer, but far from it! He cannot as yet, moreover, have got used to an apparatus the construction of which was finished but a month ago. It will, therefore, be necessary to wait, in order to see all the merit of this invention, in which we have full faith, for the return of fine weather, in the first place, and then for the riding by a true racer, who has been well broken in to the new simultaneous exercise of the arms and legs.

Our ordinary bicycle, at every revolution of the pedal, makes a distance of 5·75 meters. That of Mr. Valere makes nearly 8 meters without the least supplementary fatigue to the rider. A machine for the track that will make 10 meters is now in course of construction.

In the present state of cycle construction such figures ought to make experts incredulous. And yet here is a machine that we have seen running upon soft roads (unlike so many inventions that operate in theory, upon paper) and that passed before our eyes like a little locomotive upon which a man in comfortable attitude was trotting along at a great racing pace. We hope that the coming experiments will demonstrate all its superiority to our present types.—*La Nature*.

IMPROVED PLANING MACHINE.

THE planing machine which we illustrate has been constructed by Messrs. Sharp, Stewart & Co., of the Atlas Works, Glasgow, and in general design, says *Engineering*, is similar to the machines made by this company for a number of years. This is in particular the case with the driving gear, which consists of a rack below the table, gearing with which is a pinion having helical teeth. The teeth are machine-cut, and a very smooth motion is attained. The wear also is small, as, though upward of one thousand machines with this type of gear have been supplied by the company, in no instance have they yet had to replace either wheel or rack. The machine is very rigidly constructed, and it is claimed that higher speeds than were formerly possible can be attained in both the cutting and return strokes, there being an entire absence of shock and vibration. Its feature of special interest is, however, the feed motion (Robinson & Oldfield's patent) with which it is fitted, the arrangement of which is shown in Figs. 2 and 3. In this A and B represent tappets attached to the table of the machine in such a way as to strike the reversing lever, C (Fig. 3), and the feed tappet, D, which are perfectly independent of each other, thus reversing the machine and actuating the feed mechanism at the same time. Owing to this arrangement, the machine can by means of the handle be stopped, started or reversed without moving the feed gear at all. Thus, if any accident happens to the tool, it is only necessary to move the lever, E, to stop the machine, and there is no risk of putting in a cut accidentally while bringing the machine to a stand. The feed tappet, D, is carried by a slide, and on the top of the stud fixing the tappet there is a hardened steel runner or die, which engages with a helical cam, F. As D is moved to the right or left, this cam revolves and actuates the vertical shaft, G, through the feed gear, H. This shaft, G, operates the feed screws of the tool boxes. The tappet, D, is adjustable in its slide and can be arranged to receive an impetus either from A or B, and either sooner or later in the stroke of the table, thereby giving a variable feed, the range being from $\frac{1}{32}$ in. up to 1½ in. The change from one rate of feed to another is very quickly made. The feed is "put in" in as short a travel of the table as in the ordinary mechanism, and there is no drag of the tool over the work in the return stroke. The machine shown in the engravings can plane castings, if necessary, 4 ft. by 4 ft. by 10 ft., and the feeds can be given either up or down, right or left, and at any angle. In all cases the feed is "put in" at the end of the return stroke.



IMPROVED PLANING MACHINE.

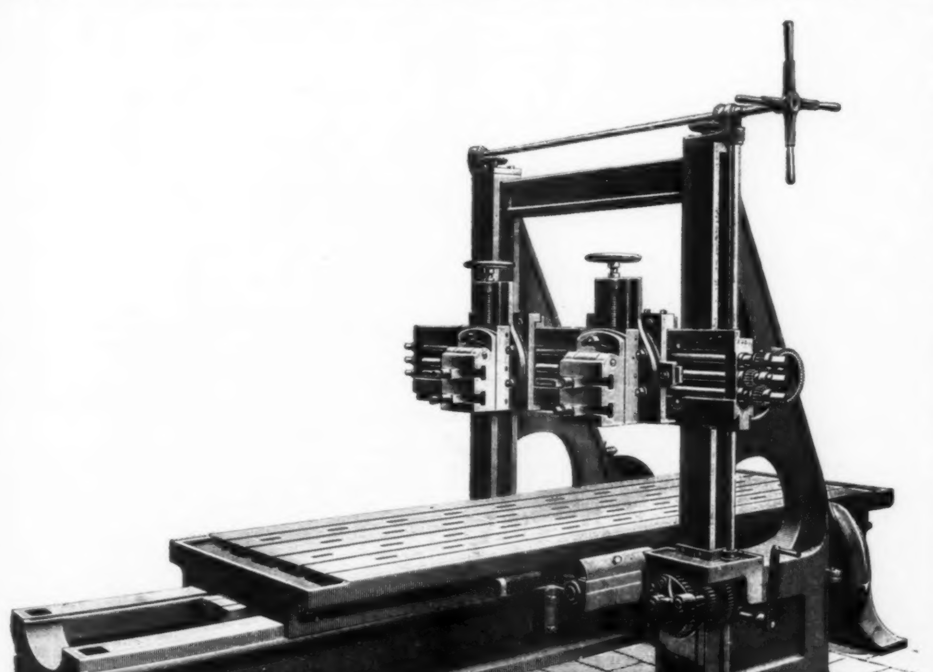


Fig. 1.

IMPROVED PLANING MACHINE.

METALLIC LANTERN SCREENS.*

By W. H. HARRISON.

ONE portion of the recent invention by Mr. Anderton in relation to lantern stereoscopic projection may have the effect of drawing more attention to the subject of screens. The photographic society might have done well to settle certain points while it had the silver-faced screen in use, for brilliancy of image is one thing, perfection of color is another.

Should the image have too metallic a luster to be altogether pleasing, the invention may yet lead to improvement of the ordinary images should a screen with semi-metallic luster be found to increase the light, without deteriorating the color of the picture. By semi-metallic we mean a luster something like that of artificial pearls, which consist of large hollow glass beads coated inside with fish scales ground up in a suitable medium, with which medium a screen might be painted.

The great founder of photography, Nicephore Niepce, lived near the little town of Chalons on the Saone, one of the best of the Continental seats of the industry of making artificial pearls, which pearls were invented by a Frenchman of the name of Jaquin. The scales of the bleak—a little fish common in the Thames, the Rhine, the Saone, and in most rivers of Europe—are thrown into a solution of ammonia, which helps to preserve them on the one hand and gives them a degree of softness and flexibility on the other. The liquor employed to make artificial pearls is an article of commerce, known as *Essence d'Orient* or oriental essence. The chief of the few seats of the artificial pearl industry are in France, but there are a limited number elsewhere. The products differ in quality.

Before quitting this fishy subject, some lantern effects may be noticed which were produced some years ago at an exhibition of articles of luxury in Nice, during the English season there. One of the rooms connected with the exhibition was normally kept in darkness, but its walls formed an aquarium, behind the glass sides of which were numerous fish with silvery scales, common in the Mediterranean. Out of sight, above the tanks, were electric lanterns, casting their beams upon the silvery sides of the fish, so that the room was chiefly illuminated by means of these living mirrors, moving restlessly to and fro, and casting flashing beams of light among the spectators. It was a pretty fantasy, eminently French in its conception and execution.

In making artificial pearls, sometimes the lustrous matter is suspended in gum, and the outside of the little glass globe containing it is deadened with hydrofluoric acid.

An opening seems to exist for experiments to determine the best surface for a lantern screen between that of dead white and metallic luster.

Supposing dead metallic screens to be advantageous for ordinary purposes, the Germans have been clever in making "silver paper" of tin, which is economical. This paper is used for wrapping tea and edible articles, consequently, under the German law, it must not contain more than one per cent. of lead. The full details of the manufacture of this paper had been kept somewhat a trade secret, until Herr A. Harpf gave the particulars in a German periodical; an abstract of his statements appeared recently in the Proceedings of the Institute of Civil Engineers. Herr Harpf was for some time in charge of a manufactory of the "argentine," as the tin deposit is called.

The manufacturers start with a solution of tin in hydrochloric acid, and get the metal from waste tin materials, such as bearing-metal turnings from railway repairing shops. For lantern screens it would be cheap enough to start with already purified stannous chloride, which should be placed in vats in which plates of zinc are suspended, when, if all conditions are right, the tin precipitates as a gray spongy mass,

* Abstract from the *Magic Lantern Journal*.

and hydrogen is evolved. The spongy mass is dried, and rubbed through a sieve to a fine dust. The author says that two methods are employed of coating paper therewith: "In the first, 4 kilos of wax, and three-quarters of a kilo of potash are boiled with 50 kilos of water, and the melting fluid so produced is stiffened to a thick paste by stirring the tin precipitate into it. In the second, 75 liters of freshly made 4 per cent. starch solution are mixed with 750 grammes of a wax solution, prepared from 5 lb. of wax and 1½ lb. of potash dissolved in hot water, and 25 kilos of argentine are added. The paste so obtained is printed by rolls on to paper, which dries to a dull gray tone, but becomes bright when burnished by passing between hot calendar rollers, when it exactly resemble tin foil." What is wanted for Mr. Anderton's lantern screens is a state of brightness midway between the two extremes just mentioned.

Real silver paper is sometimes made by covering white paper with a priming of white lead and size, and cementing silver leaf thereupon.

The powdered aluminum of different degrees of fineness now obtainable in the market seems to be about the best substance for use in experimenting in the direction now under notice, especially as it is not attacked by sulphur in the air. Used pure, it perhaps gives as high a metallic luster as will ever be required, and its luster may conveniently be reduced, if necessary, by admixture with a suitable white substance, preferably sulphate of barium, which is practically unchangeable. The powders can be applied as a paint in any suitable vehicle, such, for instance, as size. The Lantern Society might do useful work in experimentally investigating the merits of different semi metallic screens.

FIREPROOF FLOORING.

WE propose in the following lines to give a few data in regard to the various systems of fireproof flooring employed in Europe and the United States.

A Few Examples of the First Fireproof Floors.—The oldest known attempts made in England to render floors incombustible were those due to the builders of Nottinghamshire and Derbyshire, who employed plaster. In 1766, David Hartley constructed a fireproof house upon the territory of the parish of Putney, and, in the presence of the King of England, the court and the lord mayor, the lower story was filled with inflammable materials, which were set on fire, while the inventor and some friends remained in the upper story. The experiment was so successful that the English Parliament voted the inventor a gift amounting to $12,500 and extended his patent thirty-one years. Hartley's method consisted in fixing incombustible plates above and below wooden floors, and filling in the space between them with dry rubble and sand. This inventor, however, had but few imitators.

The oldest form of incombustible floor was the brick vault, the springings of which rested upon metallic girders, and the first known example of this application is that of Phillips & Lee's works, at Manchester, built in 1811. The girders were of cast iron, spaced 10 feet apart. This system was generally adopted in the construction of stores and cotton factories, and is still employed in our day, with the only difference that girders of rolled iron have been substituted for those of cast iron. The regulations for the structures erected in a large number of English cities even specify the use of this kind of flooring, and it is only by an ingenious interpretation of the clauses of the conditions of the permit that any one succeeds in substituting more improved systems for it.

Messrs. Woodhouse & Potts have modified the system by having cast in a piece, on each side of the girder, frames upon which rest small rolled beams spaced 30 inches apart, and supporting the brick vaults laid in segments (Fig. 1). In another system, due to Mr. Scott (Fig. 2), the panels are generally 10 feet in length, and, with the columns, are cast in a piece with the corbelings, to which are bolted small rolled beams rendered rigid against each other by means of cast iron girders. It is upon the small beams that the brick vaults rest. Although in this system a saving is gained in brick masonry, a large part of the iron work is left exposed—a serious defect in case of fire.

Sir William Fairbairn has devised a form of flooring (Figs. 3 and 4) in which the intrados of the vault consists of flat irons ¼ of an inch in thickness, spaced 36 inches apart and connected with each other by means of $\frac{4\times2}{\frac{3}{16}}$ T-irons. Cross braces spaced 9 feet apart are fixed to the summit of rolled irons spaced 10 feet apart. The space between the flat irons and the level of the flooring is filled in with beton. The flooring is afterward constructed, as desired, of flag stones, tiles, wood or cement. A modification of this system has been proposed by Mr. Moreland, who employs corrugated instead of flat iron (Figs. 5 and 6). The objection has been made to this and the preceding system that they are exposed to a rapid deterioration through humidity.

With the object in view of reducing the great weight of floors formed of ordinary brick vaults, Sir William Fairbairn, in 1854, employed floors of hollow bricks in the construction of the Saltaire Mills (Figs. 7 and 8). The cast iron girders are spaced 10 feet apart. The vaults have a pitch of 6 inches, and the hollow bricks are 9 inches in height at the springings of the vault (Fig. 6) and 4½ inches at the key. The space above, up to the level of the floor, is filled in with lime and cinders, and the floor is of flags or tiles Hollow bricks, known in England by the name of "arch pots," were employed on a large scale at a certain epoch. They were used, for example, in the construction of Buckingham Palace, of some of the floors of the National Gallery, of the buildings of the English Treasury, of the United Service Club, as well as for the cupola of the Bank of England (Fig. 9). Fig. 10 gives views of these arch pots on a larger scale. The span of the vault was generally 6 feet, and never exceeded 7. The pitch was less than 6 inches. The pots were 8 inches in height and 4¾ inches in width at the top and bottom. The sides and lower surface were notched in each pot to allow the mortar to enter.

The floor of vaults formed of bricks seems to have been abandoned for the first time by Dr. Fox, of Bristol. The system of flooring due to this inventor, and improved by Barrett in 1853, is known as the Fox & Barrett system (Figs. 11 and 12). It is formed of small rolled beams, spaced 20 inches apart and resting upon the main girders, and of wooden ashlering of one inch section placed upon the lower chords of the small beams at 1½ inches distance from each other. Above the ashlering and between the small beams beton is run in, the ceilings being constructed as usual, and the floor being of flags, tiles or wood, as may be desired. This is the first system in which an endeavor has been made to protect the iron girders. It was applied in the construction of the Liverpool Exchange. For the construction of the roof the system was modified according to the suggestions of a foreman. Instead of wooden ashlering, he proposed to place triangular hollow tiles (Figs. 13 and 14), which, while diminishing the weight of the floor, increased its strength and possessed a greater refractory capacity, due to the nature of the materials and to the air confined in the tiles. Moreover, the beton above could be run in without making use of centerings. Mr. Barrett gives the following mean weights: Wood floor, 35 to 40 pounds to the square foot; floor of the Barrett system, 75 pounds to the square foot; brick vault of 365 feet, 68 pounds to the square foot; brick vault of 730 feet, 115 pounds to the square foot.

The floor proposed by Mr. Clark Bunnett is a flat one of beton, slightly resembling that of the Fox & Barrett system, the wooden ashlering being fixed to the upper chords of the small beams by means of cramps, and the beton being run in up to the level of the ashlering. A layer of cement is spread over the beton and the planks forming the floor are fixed to the ashlering.

In 1862 Mr. Allen took out a patent for a special beton composed of Portland or other cement mixed with fragments of blast furnace coke or furnace bricks in the proportion of one part of cement to six parts of the other materials for a strong beton and one to eight for ordinary beton. He used it instead of stone for floor vaults and for other parts of edifices. At the time of a great fire which in 1871 consumed a six-story house at Finsbury, and all the stone and wooden portions of which were destroyed, some lintels constructed of the Allen beton were in nowise affected by the intense heat.

One of the oldest floorings in which the problem of a metallic construction with girders was realized is due to Mr. Whichcord, who, in 1873, proposed a special framing of fire bricks that surrounds the web and lower chord of the iron girder, as shown in Fig. 15. The blocks were about 738 feet in length, and their form permitted of utilizing them for the bed of the first voussoir of the vault. The bricks, as well as the blocks in question, were fixed in cement, care being taken to give them the possibility of expanding. This inventor constructed an experimental furnace 15 feet in length by 11 in width and 5 feet in height, against the walls of which were supported the lateral vaults, thus representing as well as possible the small vaults of a floor. The latter was loaded uniformly with 6½ tons, which represents a quarter of the breaking load of the bricks. Afterward a very intense fire was lighted in the furnace and was kept up for two hours and a ha f, when the bricks were suddenly sprinkled with water. The girder was deflected 1¼ inch while it was heated, but resumed its normal position after cooling. It was in no wise damaged, but the bricks were vitrified. A second experiment was made, after the furnace had been reconstructed, in submitting the floor to a very intense heat for an hour and a half, and to a medium fire for 27 hours, after which it was cooled by a stream of water. The result was again very satisfactory; the fire bricks were in nowise damaged and the small iron beams remained perfectly straight and sound.

Mr. Archibald Dawnay has devised a system of flooring consisting of a solid block of beton placed between the small beams of a flat ceiling. Flat irons of one-half inch section, spaced 12 inches apart, or small beams of 3 inches section spaced 18 inches apart, are laid upon the lower chords of transverse girders, which, for an interspace of 7 feet, must have a height of 5 inches. Beneath the girders are laid flat irons, and a beton composed of Portland cement and fireclay is run in. The floor and ceiling may be established as desired. The various arrangements are represented in Figs. 16 to 18. The weight of a floor for a span of 12 feet is about 40 pounds to the square foot.

A modification of the Fox & Barrett system, due to Mr. Phillips, has been employed by the Measures Brothers since 1862. These floors are of beton, and, instead of small wooden beams, T irons, spaced 9 inches apart, are used (Figs. 19 and 20).

In more recent constructions (Figs. 21 and 22), light rolled girders are laid in beton. The floor boards are placed upon small wooden beams fixed to the upper surface of the block of beton, a stratum of air being left between the beton and floor, this, according to the inventor, preventing rot and deadening the sound. The drawback to this system is that many metallic pieces remain without protection against fire.

Messrs. Homan & Rodgers have taken out several patents for fireproof floors. The first, dating back to 1865, consists of a beton vault of a normal span of 10 feet. The objection made to this system is its great weight, which is about 1½ pounds to the square inch. The following patent, taken out in 1871, has for its object the flat type (Figs. 23 and 24), in which small iron or steel beams are laid in beton. The weight per square foot of a floor 20 × 10 feet thus formed is 54 pounds. The third patent, delivered in 1885 (Figs. 25 and 26), concerns the use of special hollow bricks laid upon small rolled beams that carry the beton, the latter being laid without the use of centerings.

This system resembles that employed in the construction of the Commercial Exchange of Liverpool (Figs. 13 and 14).

Messrs. W. H. Lindsay & Co., of Paddington, have adopted an effective combination between iron and beton, the floor and ceiling being flat.

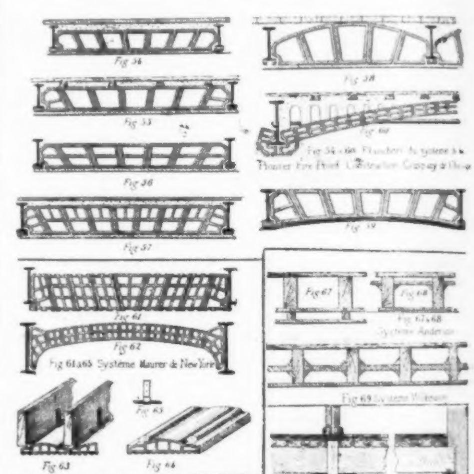
The dimensions of the small rolled iron or steel beams, as well as their distance apart, depend upon the span and the load. They are rendered rigid by means of rods (Fig. 27) passing alternately above and below the beams at intervals of about 18 inches. The entire metallic part is afterward embedded in beton composed of coke dust, sand and Portland cement. The advantage of this system resides in the fact that the iron rods increase the strength of the floor, and, besides, support the beton in its position. In another type of floor advocated by the same builders the stiffening rods are suppressed and the beton assumes the form of flags (Fig. 28).

A patent giving provisional protection was delivered in 1866 to Mr. Richard Moreland for his invention of a type of floor (shown in Fig. 27). It consists of lattice girders resting on each side upon a column and extending from one end to the other of the edifice. Transverse bowstring girders, formed of angle and flat irons, are each of them fixed upon a column. The columns are spaced about 3¾ feet apart. The whole is afterward encompassed by a solid block of beton, which constitutes a floor possessing great strength. The advantage of this system is that the beton is in the form of a single block.

A strike having taken place among the carpenters of Paris in 1840, contractors conceived the idea of substituting iron and beton for wood in the construction of floors. The system of Vaux and that of Thuasne were then generally adopted. The first consists of flat irons curved at their extremities (Fig. 31) and resting upon the walls. Upon these irons are laid rods of square section that carry transverse rods. Flat centerings are placed beneath and the beton run in completely surrounds the metallic structure. In the Thuasue system, small rolled beams slightly curved and spaced 24 inches apart are used. These are connected at about every 36 inches by cross pieces of flat iron whose extremities are curved above the upper chord of the girder, and upon which are placed square rods as in the Vaux system. The beton is run in in the same way. In both cases the ceilings are finished in plaster, and the floor may be formed of any kind of material desired. This system was adopted in the construction of a part of the flooring of the Louvre.

Another process generally used in Paris consists of a vault of hollow bricks, the springings of which rest upon small iron beams and the intrados of which is covered with plaster in order to form a flat ceiling.

A system devised several years ago by Messrs. Dennett & Ingle, of Nottingham, has been adopted in the construction of a certain number of public edifices in England. It consists (Fig. 32) of a beton vault



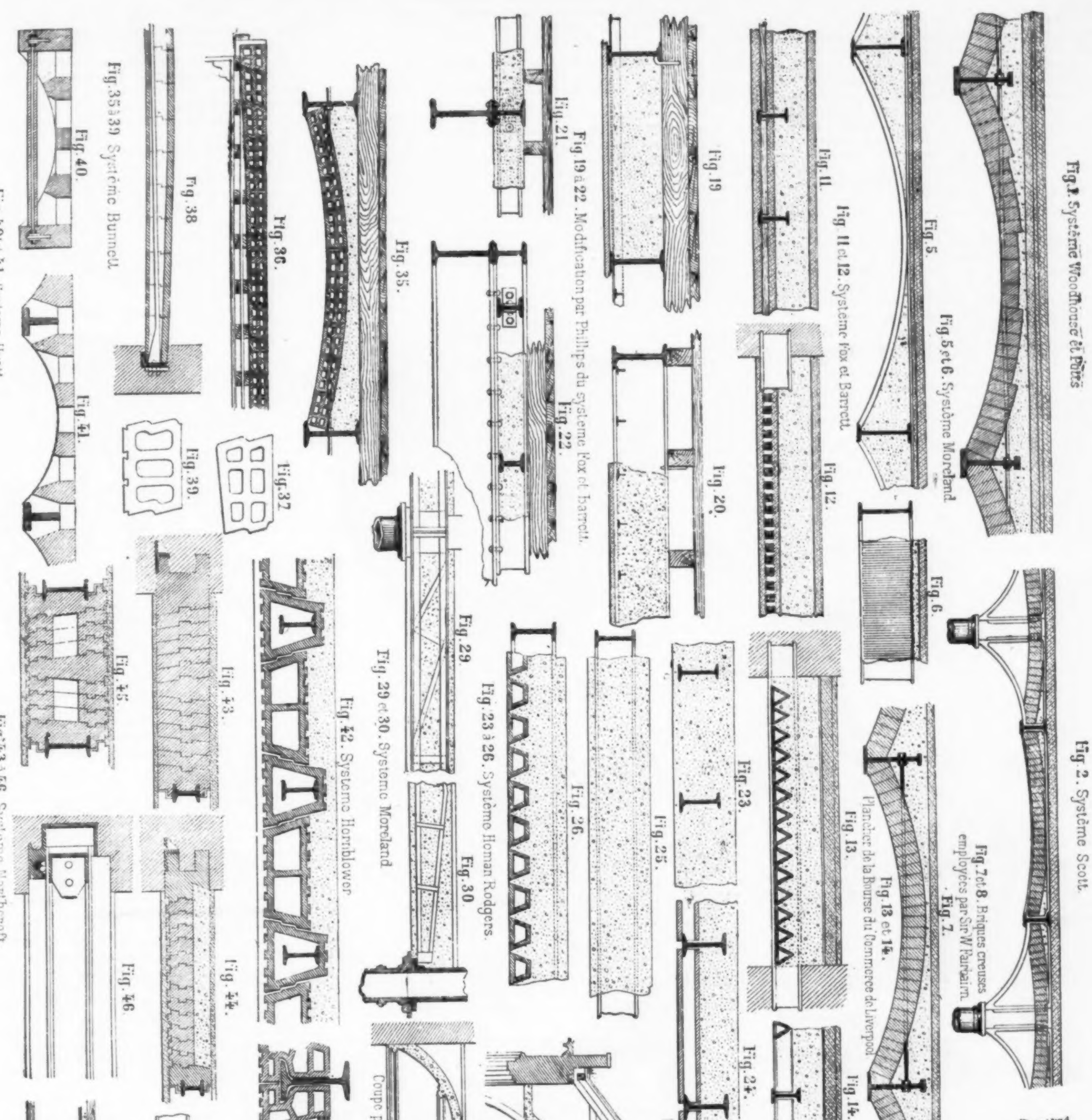
EXAMPLES OF FIREPROOF FLOORS.

having for its base gypsum mixed with pounded bricks, chippings of stone, etc. This beton is spread upon centerings, and the haunches of the vault are filled up to the level of the floor, or else they are left empty. Fig. 33 shows a section of the ceiling of the council hall of the new Foreign Office. The cupola is 36 feet in diameter and 9 inches in thickness at the pendentives. Fig. 34 shows a section of the cupola situated over a tiring-room of Her Majesty's Theater, of London. It has the following dimensions: 30×20×5 feet. Numerous experiments have been made with these floors and they have given good results. Figs. 35 to 46 show a series of hollow brick floors of a special model. What precedes renders it unnecessary to give a detailed description of them. It will suffice to say that the inventor of the floor represented in Figs. 40 and 41 directs attention to his system in calling it the joist vault, allowing the light to pass.

Messrs. Doulton & Co., of Lambeth, have proposed a system of flooring (Fig. 47) in which hollow summers encircle the girder or floor timbers, the voussoirs consisting of hollow bricks one of the sides of which presents the same angle as the summers. These bricks are of special fire-clay. In addition to the joints between the bricks, smaller tail grooves are formed into which the cement can enter. The lower surface of the platband is likewise provided with the same kind of grooves into which enters the plaster forming the ceiling.

With the systems represented in Figs. 48 to 53 we have finished with the floors devised in Europe, and shall now pass to those invented in America.

American Floors.—In the construction of floors the Pioneer Fireproof Construction Company, of Chicago, employs a system of flat vaults of hollow bricks (Figs. 54 to 60). The section of the bricks depends upon the thickness of the floor, which, in turn, depends upon the length of the span. In each case, the bottom of the joint is prolonged by a longitudinal tile formed of the same material as the bricks. Fig. 60 shows some bricks designed for a vault of 60 feet span. The tympans are filled with beton with hollows at a few points to render the vault lighter. The thrust of the vault necessitates cross braces here and there, and, as the latter are placed under the intrados, they would, if they were not protected, constitute a source of danger during a fire. Iron cross braces ¾ inch in diameter are



EXAMPLES OF FIREPROOF FLOORING.

likewise placed in the system of flat vaults, and are bolted to one of the small beams at distances of from 8 to 10 feet.

Messrs. Maurer & Company, of New York, are constructing a system of fireproof floors (Figs. 61 to 65) with well baked clay firebricks. These bricks are embedded in cement, and are provided with dovetail grooves into which the cement and plaster of the ceiling can be introduced. The small beams and the joists are in each case protected by refractory materials.

The Raritan Hollow and Porous Brick Company, of New York, has got up fireproof floors formed of hollow brick vaults. The bricks are of well baked fire clay and the metallic part is protected by summers that rest upon small beams. Longitudinal grooves are moulded in the faces of the bricks in order to permit of the introduction of the cement and plaster of the ceiling.

We shall now pass to another sort of fireproof structures, and shall occupy ourselves in the first place with the application of silicated cotton or mineral wool. Figs. 67 and 68 show the manner in which this is employed by Messrs. D. Anderson & Son. In the first floor are fixed silicated flags under small iron beams by means of ashlering to which the ceiling of wood and plaster has been fixed. In the second arrangement, cleats are nailed to the joists that support the floor. Upon these cleats rest boards above which may be placed the mineral wool in a crude state or compressed in the form of flags. In the case shown in Fig. 69, a special plaster is used. This system is due to Mr. Wilkinson.

In the United States what is called the slow combustion system of flooring is often used. In this sort of construction, the external walls are of brick masonry. The floor and the roof are constructed of wood of wide section, and the floor timbers are supported by wooden columns. Figs. 70 and 71 show the principal forms of this sort of construction. A different system, from which cast iron is excluded, is due to Messrs. Evans & Swain (Figs. 72 and 73). This type of floor is employed at the East and West India Docks, of London, and in Westminster Hall, etc.—*Le Genie Civil.*

THE JINRIKSHA OF JAPAN.

THE JINRIKSHA AT HOME.

THE jinriksha is the national carriage of Japan, and a most suitable and comfortable method of locomotion in such a climate, where there are so many interesting places beyond the access of railways, and where narrow streets, lanes, and field paths are so numerous. The vehicle in question is drawn generally by a single runner. It is truly astonishing how one pair of human legs and arms can so effectually do duty for a horse, and with what activity these Jehus trot and bound along with conveyance and passenger. The runners, called in Japanese "kuruma-ya," are small, light men, active, fleet, and particularly well adapted to their calling, while the mild climate makes it less of a drudgery than would be the case under ruder skies. These *hommes-chevaux* will easily cover from forty to fifty English miles a day, stopping at intervals for food and rest at one of the tea houses passed on their journey. Jinrikshas can easily be obtained in all the towns and villages of Japan, while in larger centers they literally swarm like cabs in London. Tourists and travelers often prefer this shaft carriage to the railway for short distances, as it enables them to see more of the people and the country in the districts through which they are passing. Provided with oil paper, a mackintosh, an umbrella, a sun hat or helmet, a little tinned food, a brandy flask, putting up at night at a native tea house where rice, fish, eggs, and frequently foreign beer, can be obtained, one can accomplish journeys of great length, even of several days' duration, without much inconvenience.

Jinrikshas—the word means man-power carriage—are said to have been invented in 1870 by a Japanese, Aluka Daisuke, of Tokyo; while another report credits a Mr. Gobie, an American lay missionary, with having originated this vehicle three years earlier. There are at present said to be over 40,000 in the capital alone. The jinriksha has been introduced into Shanghai, Hong-Kong, Tong-King, and Singapore, where it is a great success and much appreciated.—*Daily Graphic, London.*

CELLAR OR NO CELLAR?

By EDWARD ATKINSON.

IN conversation many years ago with the late Dr. Agnew, of New York, of highest authority on hygiene, he told me that he thought that, for sanitary reasons, there should be no cellar under any dwelling house. If there were, he remarked, the floor above should be most carefully sealed against the passage of any cellar air into the house, while the entrance to the cellar should be wholly outside the house. This was in the beginning of my practice in dealing with the construction of factories, and it became one of the motives, aside from safety and economy, in treating the subject of the basement floor.

I now venture to put a question which has become of considerable practical importance to architects; Ought there to be a cellar, in the ordinary sense in which that word is used, under the occupied parts of buildings of any kind, such as school houses in which children are taught, factories in which men and women work, lower stories or basements of houses where much of the household work is done? In other words, ought not the lower story of almost every building to be put on well drained ground above grade, both with a view to economy in construction and for sanitary reasons, if for no other?

In factory practice all types of basement floors built of timber and plank placed a few feet above the ground, in an excavation or even at grade when not open to the air on every side, with the expectation of ventilation beneath, have failed. It may be alleged that it has proved to be impracticable to ventilate a mere air space under a basement floor of a large building over the ordinary gravel or hard pan of the soil, so as to prevent the decay of timber. In the best mill practice excavated basements or cellars, half to two thirds under ground, with cemented floors of concrete, have been sufficiently well ventilated; but the type of construction makes an expensive underground story, of which, as a rule, but a small part can be put to effective use. It is apt to cost as much or even more by the square foot of floor than any other floor surface in the factory.

On the other hand, in many workshops and in some factories it is very desirable to be able to set machinery as nearly as possible upon the solid ground with timber and plank interposed between the ground and the machine, since, for many reasons, machinery may not be placed directly on concrete. This has been safely accomplished by making the concrete over a well drained floor space with asphaltum or coal tar in place of cement. Timber and plank laid in cement will rot very speedily, and a cement concrete is a quick conductor of heat. An asphaltum or coal tar concrete properly laid is a non-conductor of heat, an antiseptic, and is impervious to moisture; upon such a surface timber and plank laid solid last as well as in any other part of a factory building.

Under these conditions, the question arises, May not expensive basements or cellar stories be done away with, except so far as it is either cheaper or more convenient to make an excavation for absolute use and not merely for the purpose of interposing a partly underground story beneath the main floor of a building?

In dealing with the condensation of moisture on interior surfaces, absolute success has been attained in preventing such condensation even over the Fourdrinier or the cylinder machines in paper mills, from which the maximum quantity of humidity is discharged in the process of converting wet pulp into dry and finished paper. Composite roofs made of proper materials six to seven inches thick have proved to be absolute non-conductors of heat, cold and moisture, and in their application to these machine rooms, with proper ventilation to remove the steam, the condensation of moisture on the under side has been wholly done away with.

Reverse this process: May we not put a composite floor underneath the lower story of a building, reversing the order of materials which are used in the roof, and in this way put an absolute non-conductor of heat and moisture between the first occupied room and the well-drained soil below this composite floor? Why not? Many examples can be cited of complete success in this practice, which is now becoming common in our lines.

The following conversation occurred between myself and a very practical man not long since, in the discussion of a building in which he desired to put all his main work on a single floor. On my suggesting this method of construction, he said, "Oh, but I must have a cellar! It would not be fit to build such a building without a cellar."

"Very well," I replied, "then we will put a cellar under your main floor. You will desire to floor your cellar, will you not?"

"Certainly."

"What will you floor it with?"

"Cement or concrete."

"Would it not be better to use coal tar or asphaltum?" explaining the reason.

"Certainly," said he, "we will adopt that floor."

"Then," said I, "you had better have a light cellar, had you not? You can afford to put your main floor considerably above grade for your purpose."

"Oh, yes; light by all means!"

"Shall we put it half way out of the ground?"

"Yes; as much as that."

"Good!" said I. Next I asked, "But where you propose to put this building will it not cost you a great deal more to excavate than it would to keep up well toward the surface?"

"Yes," he replied; "very hard place to dig."

"Then," said I, "suppose we put the cellar two thirds above ground."

"Well," he replied, "why not?"

"Now, then," I said, "you have just back of your location a good gravel bank; wouldn't it be a good deal less costly to grade up a foot and drain well than it would be to dig any hole of any kind?"

"Why, certainly," said he.

"Then," said I, "why not put your cellar floor one foot above grade and drain it well?"

"Why," said he, "what has become of my cellar?"

My reply was, "You have put it in the best place possible. With the floor one foot above ground, and that cellar wholly above ground, being placed under your main floor, will cost you less than it would to dig a great hole in the ground in which you will generate foul air and accumulate rubbish."

"But," said he, "you have given me a two-story building with two floors, and that is double the floor space that I want."

"Yes," I replied, "I have given you a two-story building with two equally useful floors at less cost than you would have put into a one-story building with a deep and almost useless cellar under it. What are you going to do about it? Will you waste your money by digging a hole in the ground?"

"No," he said.

"Well, what will you do?"

"Why," said he—"why can't I leave out the upper story and bring the roof down so as to cover in the first story?"

"Well," I remarked, "why not? I think you have landed where I meant you should. If you can cut off the passage of heat, cold, and moisture by properly constructing a composite floor directly upon well-drained ground, why do you want to dig a hole underneath it, at heavy cost?"

"But," said he, "I meant to store my coal in the cellar."

"Well," I said, "you can dig a hole for your coal if you want to; put it down in the hole in order to go through the work of bringing it up again. Why not put it in a shed in the rear on the level of the floor where you use it?"

"But," said he, "I meant to have put my sanitary appliances down below."

"Then," said I, "you would probably have made your cellar a great deal more foul than it would be under ordinary conditions. Better put them outside, for every reason, whether you have a cellar or not."

My practical man thought he had found for himself an excellent method of getting the room he needed on one floor at about three fifths or perhaps one half of what he expected it would cost him on his own plan for one floor and cellar. Yet there are still many persons who think that they must have a cellar under the main floor.

To what extent can such persons be persuaded to build their cellars wholly above grade by at least one foot?

In other words, the question put to architects and, through them, to owners, may well be, if you have no use for a cellar, why put one under your building? A building costs a certain sum by the unit of the square foot of floor, counting every floor. If the use of only one floor is called for, why put a more expensive floor ten feet below it by digging a hole in the ground? If it is expedient to use two floors and to have all the light, air and ventilation one can get on both, why make one a basement partly below ground and partly above? Why not put them both above grade?

Of course these questions apply to open spaces where it is not necessary to go down deep into the bowels of the damp earth or high up into the air in order to get floor space. On a broad area floor space on one floor can be provided at less cost than by excavating or going high into the air; on two floors at the lowest cost at which floor space can be provided in any way.

Then why provide either cellar or basement floors below grade except in deference to a superstition derived from a period when the right way of constructing a floor directly upon the ground had not been devised?—*American Architect.*

SPIDERS are not always solitary and selfish, as some naturalists have asserted. Dr. McCook, an authority on the subject, has told the British Association that "there really are cases in which the male and female spiders live in amicable relations for a considerable period."

REPORT OF THE MICROSCOPIST OF THE DEPARTMENT OF AGRICULTURE.

THE last report of Dr. Thomas Taylor, microscopist to the Department of Agriculture, contains much valuable information relating to edible and poisonous mushrooms. This is illustrated with elegant plates in colors.

Edible mushrooms, he tells us, are usually characterized by an odor like that of fresh meal, and a flavor of hazel nuts; non-edible varieties have sometimes an unpleasant odor, and produce a biting, burning sensation on the tongue and throat, even in very small quantities, but several of the *Amanitas* have only a slight odor and taste, and certain species of mushrooms, acrid otherwise, become edible when cooked.

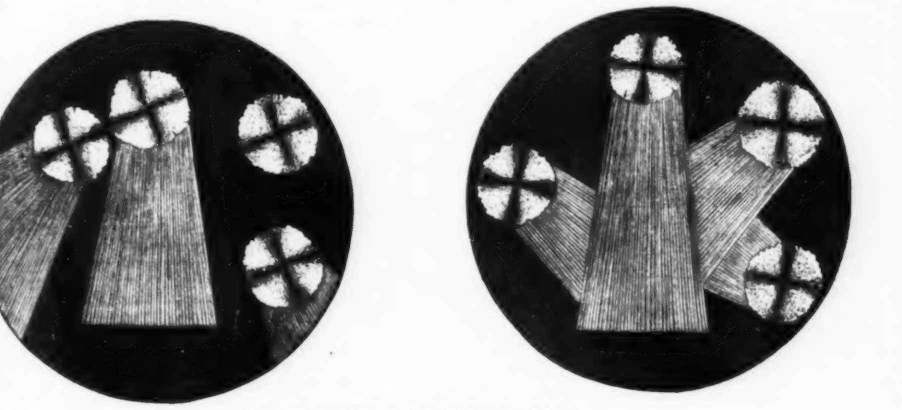
Mushrooms of vivid colors and viscid caps are not always poisonous. It is by some supposed that high colors and viscidity are indications of non-edible species, but there are numerous exceptions here. *Russula alutacea*—the pileus of which is a purplish red—*Amanita Cæsarea*, and other species of brilliant coloring are known to be edible. As to viscidity, two very viscid species, when young, are among the highly prized esculents by those who know them, viz., *Fistulina hepatica*, or the ox tongue, and *Hygrophorus eburneus*, the ivory mushroom.

Crystallization of Oils or their Acids.—Dr. Taylor describes his freezing box, a new device prepared for use with the microscope. It is the result of a long experienced want of some method of crystallizing the various oils and their acids so as to obtain micro-photographic views of their respective crystalline arrangement, a knowledge of which is important in microscopic investigations relating to the adulterations of foods and other oils. Another advantage offered by this invention is that by this method objects in natural history mounted in varnish or other media may be thrown on a screen and photographed. In the use of sunlight or Drummond light, the liquid soon reaches 212° F., and thus renders useless a valuable mount.

The freezing liquid may be used repeatedly or until it ceases to be cold enough for the purpose. Any of the usual freezing liquids or ammonia gas or ether may be used. The tube which carries off the liquid from the freezing box should terminate in a small orifice to prevent unnecessary waste.

The box is provided with an air escape to facilitate the operation of filling the box with the freezing liquid. When this is accomplished, plug the opening and secure the box in position. In using ether, remove the plug to allow the ether to escape, or insert a tube to convey it into a separate vessel, where it may be condensed.

The solid fat of the chaulmugra oil is easily separated from the oil by freezing. The fat thus procured may be mounted in the usual manner. It should then be heated sufficiently to make it liquid and placed quickly under the microscope. As it cools, crystallization rapidly progresses. At first globular masses will be observed, each one showing, under polarized light, a well-defined cross. No sooner does one of these globular masses form than a second crystallization takes place, proceeding from the globular accretion in the form of an elongated, spreading fan.



CHAULMUGRA FAT CRYSTALS.

Figs. 1 and 2 represent the crystalline forms of the solid natural fat of the oil of chaulmugra procured by the freezing process. The very peculiar forms which this fat assumes in crystallizing leads me to the belief that it is a new and undescribed fat.

A NEW SULPHIDE OF CARBON.

By A. E. TUTTON.

A NEW liquid sulphide of carbon of the composition C_3S_2 has been isolated in a somewhat remarkable manner in the chemical laboratory of the University of Buda-Pesth, by Prof. Von Lengyel, who contributes an account of it to the current *Berichte*. In addition to the well-known disulphide of carbon, several other substances supposed to be compounds of carbon and sulphur have from time to time been described; but as they appear to have been amorphous insoluble solids very difficult to purify, there is very little evidence of their being definite compounds. The substance now described, however, appears to be a very well characterized liquid compound of unmistakable odor and corrosive action upon the skin, and capable of being distilled under diminished pressure.

The method of preparing it was accidentally discovered during the elaboration of a number of lecture experiments illustrating the synthesis and decomposition of carbon disulphide. It was long ago pointed out by Berthelot that this familiar substance decomposes at a temperature but slightly higher than that at which its formation from its constituents occurs. Buff and Von Hofmann subsequently showed that the temperature of a glowing platinum wire was ample to bring about slow dissociation of the vapor, and that the disruption of the compound occurred very rapidly indeed at the temperature of red hot iron wire. An experiment was therefore arranged to ascertain whether rapid removal of the vapor of the synthesized compound from the heated sphere of action would largely prevent the loss by dissociation, and in order that the test should be a severe one, the rapidly moving vapor was subjected in its passage to the high temperature of the electric arc. It was during this experiment that the new sulphide of carbon was unexpectedly produced.

A little more than a hundred cubic centimeters of carbon disulphide were placed in a flask arranged over a water bath. A large globe had been previously sealed onto the neck of the flask, through tubuli, in which the carbon electrodes were inserted. To a third tubulus of the globe an upward condenser was fitted, the interior tube of which was finally bent downward to serve as a gas delivery tube. The water bath was then heated and the carbon disulphide maintained in rapid ebullition, the electrodes were approached until the powerful current from accumulators was transmitted, and then withdrawn so as to generate the arc. The electric arc in carbon disulphide vapor under these conditions is a remarkable phenomenon; it is seamed with a dark band passing along its center from pole to pole, and the brightest spots of the incandescent terminals are just where the band appears to touch them.

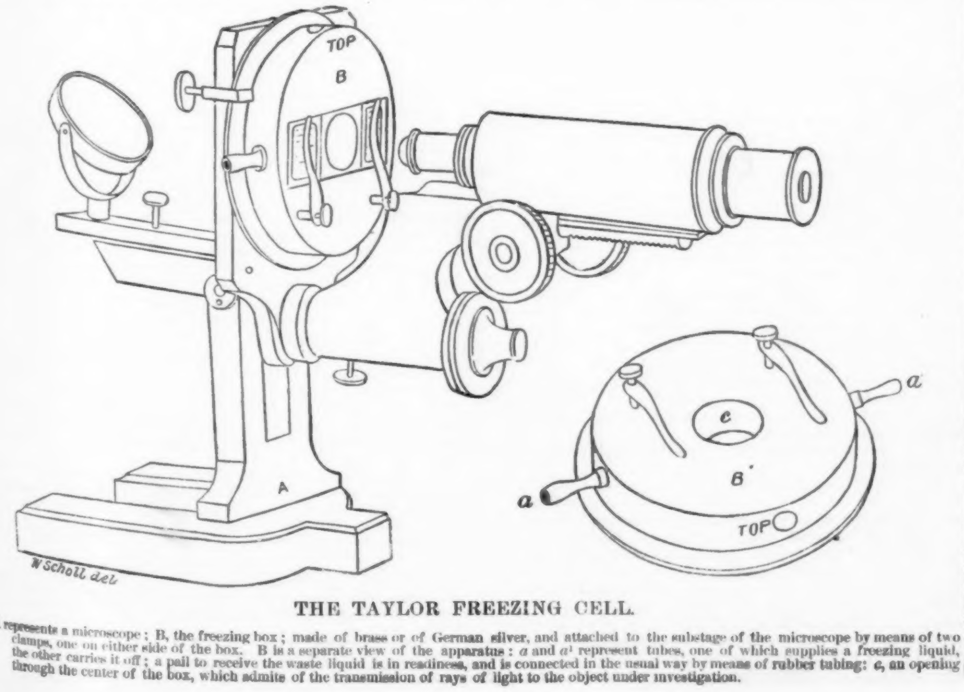
The carbon disulphide was kept boiling and the arc passing for a couple of hours, during which the globe was filled with the vapor, which condensed in the condenser and fell back into the flask. The interior of the apparatus soon commenced to blacken with liberated carbon, which collected upon the surface of the liquid, and an extraordinary strong tear-exciting odor soon made itself evident in the neighborhood of the apparatus. At the conclusion of the experiment the residual liquid was cherry red in color, and was transferred to a closed vessel containing copper turnings, in order to remove the free sulphur present. After being thus left for a week it was filtered, and the carbon disulphide evaporated at a low temperature in a current of dried air, in order, if possible, to isolate the substance endowed with the powerful odor. Eventually a few cubic centimeters of a deep red liquid, the new sulphide of carbon, were left, which possessed the odor in greater intensity, a trace of the vapor producing a copious flow of tears, accompanied by violent and persistent catarrh of the eyes and mucous membrane. A drop of the liquid, moreover, at once blackened the skin.

The specific gravity of this liquid is 1·2739, so that it sinks under water, with which it does not mix. When heated it polymerizes into a hard black substance. If the rise of temperature is gradual the change occurs quietly, but when rapidly heated to 100–120° the polymerization takes place with explosive force, the interior of the vessel being covered with projected deposits of the black substance. Analyses, both of the liquid and of the black solid, indicate the same empirical formula, C_3S_2, and molecular weight determinations of the liquid, dissolved in benzene, by Raoult's method, agree closely with the molecular weight corresponding to that formula. The liquid can be partially distilled at 60° *in vacuo*, a small portion, however, always polymerizing. The liquid, moreover, spontaneously changes in a few weeks into the more stable black solid modification. The solutions of the liquid in organic solvents likewise slowly deposit the black form.

The liquid readily ignites, burning with a luminous flame and forming dioxides of carbon and sulphur. Caustic alkalies dissolve it, forming dark-colored solutions, from which dilute acids precipitate the polymerized back compound. With alcoholic potash the action is very violent. A drop of concentrated sulphuric acid causes instant passage to the black form accompanied by a hissing noise. Nitric acid provokes an explosion and ignition; but 70 per cent. acid dissolves it completely and quietly.

The black polymeric modification is readily soluble in caustic alkalies, but acids reprecipitate it unchanged. When heated it undergoes a remarkable change, sulphur subliming, and a gas, inflammable and containing sulphur, but not carbon disulphide, is liberated, the nature of which is reserved for a further communication.

The liquid sulphide combines readily with six atoms of bromine, with evolution of heat. The substance is readily isolated when bromine is dropped into a solution of C_3S_2 in chloroform, as it is insoluble in that solvent. Strangely enough, this compound, $C_3S_2Br_6$, is endowed with a pleasant aromatic odor, two substances of frightful odors thus uniting to form an agreeably odoriferous compound, a striking example of the effect of chemical combination.—*Nature.*



THE TAYLOR FREEZING CELL.

A represents a microscope; B, the freezing box; made of brass or of German silver, and attached to the substage of the microscope by means of two clamps, one on either side of the box. B is a separate view of the apparatus: *a* and *a*¹ represent tubes, one of which supplies a freezing liquid, the other carries it off; a pail to receive the waste liquid is in readiness, and is connected in the usual way by means of rubber tubing: *c*, an opening through the center of the box, which admits of the transmission of rays of light to the object under investigation.

NITROGEN AS FOOD FOR ANIMALS AND PLANTS.

By VAUGHAN CORNISH, M.Sc., F.C.S.

"THE atmospheric fluid, or common air," Lavoisier wrote, "is composed of two gases or aeriform fluids, one of which is capable, by respiration, of supporting animal life, and in it metals are calcinable and combustible bodies may burn; the other, on the contrary, is endowed with directly opposite qualities—it cannot be breathed by animals, neither will it admit of the combustion of inflammable bodies, nor of the calcination of metals.

"We have given to the base of the former, which is the respirable portion of atmospheric air, the name of oxygen. . . . The chemical properties of the noxious portion of atmospheric air being hitherto but little known, we have been satisfied to derive the name of its base from its known qualities of killing such animals as are forced to breathe it, giving it the name of *azot*, from the Greek privative particle α and ζωη, *vita;* hence the name of the noxious part of atmospheric air is *azotic gas*."

Lavoisier, who was the first clearly to state the chemical nature of air as composed of two substances, one chemically active and the other chemically inert, occupied himself for many years in developing the knowledge of the chemistry of oxygen—the active constituent of air. The readiness with which oxygen gas can be made to act upon and combine with other substances enables its chemical functions to be determined with comparative ease, and the mode in which this element is used in the nourishment of the animal body was soon elucidated with tolerable completeness; on the other hand, the inertness of *azot* (or nitrogen, as the substance soon came to be called in England) rendered the chemical study of this constituent of the atmosphere a less attractive as well as a slower and more laborious pursuit. Thus, if we compare the ways in which the oxygen and nitrogen of the air are taken hold of to build up the animal body, we find that one process is direct and in its main features simple, whereas the processes by which the nitrogen of the air becomes a constituent of the flesh and muscle are, on the contrary, indirect and complicated. Even at the present time, a hundred years after the researches of Lavoisier, the mode of "assimilation of nitrogen" is only beginning to be understood. When air enters the hollow cells of the lungs, the blood, flowing round the cells in little veins and capillaries, seizes upon and "fixes" the oxygen, which freely passes through the thin walls of the air cells, and carries to every part of the body the combined oxygen which it has thus seized upon. Parting in its passage through the body with the oxygen which it has seized

from the air, the blood acts as carrier of oxygen from the air to the muscle, flesh, nerve, and other parts of the body. But the blood has no power to seize upon and fix the nitrogen gas which enters the lungs at every breath. The blood has to obtain its nitrogen from the animal and plant food which is taken into the stomach; the throat and not the windpipe is the channel by which the nitrogen of the air is supplied to the body. Animals used by man for food obtain their nitrogen from plants. Plants have to depend ultimately upon the air for their supply of nitrogen.

The plant, however, does not appear to be able to assimilate the free atmospheric nitrogen through its leaves any more than an animal can assimilate the gas through its lungs. Leaves catch the carbonic acid of the air as the lungs of animals catch the oxygen of the air; but the nitrogen, it seems, has to reach the sap through the roots—it has to be fixed in some way—before the plant can feed upon it. Recent researches seem to have proved that on leguminous or pod-bearing plants there lives a class of bacteria which have the power of feeding directly upon the free nitrogen of the air. They "fix" the nitrogen, which afterward becomes available for plant food. Perhaps this only happens after the death of the bacteria, when their substance has undergone decomposition and the nitrogen compounds have been converted into a soluble form, so that they can enter the sap in the same way as the rest of the food derived by plants from the soil.

The soluble form in which it appears that nitrogen is mostly taken up by the roots of plants is known as the nitrate "form" or state of combination, in which nitrogen is combined with oxygen as it is in niter and in nitric acid. Besides bacteria associated with leguminous and possibly other orders of plants, there is another agency which brings the nitrogen gas of the atmosphere into combination with oxygen; this agent is electricity. Electric discharges in the atmosphere cause the combination of relatively small quantities of nitrogen, and the soluble oxides of nitrogen thus formed are carried down in solution by the rain, thus adding to the quantities of nitrates in the soil. As far as it is at present known, these two agencies, electricity and bacterial life, are the only carriers of nitrogen from the air to the soil.

Most of the nitrogen at any moment present in the world's soil is, however, derived from the substance of the preceding generations of plants. The nitrogen required to be supplied to the world's soil for the crop of any one year is only the difference between what is abstracted from the soil by the plant crop and what is restored to the soil by the death and decay in the vegetable and the animal kingdom.

The difference between the two amounts may be relatively small for the whole of the earth's surface, and might perhaps be *nil* if large quantities of nitrogen as nitrate were not being constantly carried into the sea by rivers.

The nitrogen in vegetable and animal substances is combined with carbon, and nitrogen in this state of combination may be termed *organic nitrogen*. Nitrogen when in this form is not directly available as a food for plants. By the process termed decay in the case of plants, and putrefaction or decomposition in the case of animals, the nitrogen is set free from its combination with carbon, and ammonia or a compound of ammonia is produced. In ammonia, nitrogen is in combination with hydrogen; and nitrogen, in this state of combination, we will call *ammoniacal nitrogen*. Free ammonia gas, formed in the decomposition of materials containing organic nitrogen, is ultimately brought into the soil in a state of solution by means of rain or dew, owing to the fact that ammonia gas is extremely soluble in water. Much of the ammonia produced by the decomposition of organic matter meets at once either with water or with some material with which it can combine, and thus from the first is retained in the soil. Plants are able to feed directly upon ammoniacal nitrogen; but in the greater part of the nitrogenous food of plants the nitrogen is in combination with oxygen, *i. e.*, in what we have termed the "nitrate" condition. The decomposition of the organic matter of the soil (which is commonly called *humus*) is effected through the agency of the *nitrifying bacteria*. They first split up the organic matter into water, carbonic acid, and ammonia, and then further assist the oxidation of ammonia to nitric acid. The conditions favorable to nitrification are that the oxygen of the air should have free access, that the soil should be sufficiently moist, but not water-logged, and that the temperature should be fairly high. In the presence of an alkali or alkaline earth in the soil, the nitric acid forms a salt (termed a nitrate). Where lime or carbonate of lime is present, soluble calcium nitrate is produced, and in this form plants obtain much of their nitrogen. Where potash is present, niter or saltpeter is formed, as, *e. g.*, in dry districts of India, where niter is found as an efflorescence on the surface of the soil. Chile niter, or Chile saltpeter, is the nitrate of sodium, and occurs in large deposits in the rainless districts west of the Andes, in Chile and Peru. In a wet climate such deposits would be speedily washed away, and carried into the rivers and the sea. We have referred before to the loss of the nitrogen which the soil of continents undergoes on account of soluble nitrates finding their way into the sea. The great quantities of nitrates from Chile and Peru which have of late years been applied to the fertilization of the land are a contribution won back from the ocean; the nitrates of the nitrate beds have been formed by the oxidation of guano, the *dejecta* of fish-feeding sea birds. Recently "artificial guano" has been manufactured to a considerable extent from the carcasses of coarse fish, caught for the purpose by fishing from ships specially employed in connection with this manufacture.

Where crops are cut and carried from the place where they are grown, it is necessary to provide for the restoration to the soil of certain materials, particularly nitrogen, which are thus removed instead of being allowed to return to the soil through the death and decay of the plants, as would be the case in a state of nature. This is partially effected by returning to the soil the manure from the animals of the farm which fed upon the crops. When the beasts themselves, however, are sent into the towns, they carry away large quantities of the particularly valuable constituents of a fertile soil, such as nitrogen and phosphorus. In a more primitive condition of agriculture, the beasts would be eaten on the farm itself, and the greater part of the nitrogen, etc., would find its way back to the soil whence it came. Facilities for communication and transport, however, and the concentration of the population in towns all tend to make farming, more particularly manuring or soil feeding, a more complicated matter. This is especially the case where nitrogenous stuff, *e. g.*, hay, is sold off the farm, instead of being consumed upon it, and oil cake or other artificial feeding stuff is purchased in its place. The oil cakes are rich in fat as well as in nitrogen, but the albuminoid ratio is always high, in some cake as high as 5:7. The method of calculating the nutrient or albuminoid ratio was explained in a former article (*vide Knowledge*, July, 1893). Account has to be taken of this ratio in deciding upon combinations of artificial foods for the use of stock, just as the authorities of prisons, etc., have to consider the nutrient ratio of the diet they supply. Young growing animals retain a larger proportion of the nitrogen supplied to them than the full grown beasts which are being fatted. In the former case much of the nitrogen goes to build up the muscular flesh, and the manure given by young growing animals is proportionately poorer in nitrogen. On the other hand, full grown animals which are being fatted for market store up chiefly fatty tissue, which contains no nitrogen, and consequently these animals return a larger proportion of nitrogen to the ground. In feeding different species of animals account has to be taken not only of the albuminoid ratio but of what is called the *digestion coefficient*, or proportion which the food stuff taken bears to the amount digested.

This proportion is different in the case of different species of animals. In the case of ruminants a large proportion of indigestible fiber in the food is actually necessary. Sheep cannot assimilate more than half of the 12 per cent. of nitrogenous matter contained in clover hay. Human beings would be able to assimilate scarcely any of the nutriment in hay, the White King, in "Through the Looking Glass," who took hay when he was faint, being of course an exception to the rule. By submitting the hay to preliminary treatment by an ox or sheep, man is able to assimilate the nitrogen and other nutrients contained in hay in the form of beef or mutton.

To sum up, we may say that nitrogen exists as

1. *Atmospheric nitrogen*, in which *the atoms of nitrogen are combined with each other*. The bacteria associated with leguminous plants feed upon atmospheric nitrogen.

2. *Ammoniacal nitrogen*, on which plants can, and to some extent do, feed. *Here nitrogen is combined with hydrogen*. The source of ammoniacal nitrogen is the decay of animals and plants.

3. *Nitrate nitrogen*, in which *nitrogen is combined with oxygen*. This is the principal form in which plants obtain their nitrogen. Nitrates, generally speaking, are formed by the oxidation of the ammoniacal compounds produced in the decay of animal and vegetable matter. In the presence of alkalies in the soil, such as lime and potash, soluble nitrates are formed which supply both nitrogen and alkali to plants. Nitrate nitrogen is also brought into the soil by the action of electrical discharges in the atmosphere.

4. *Organic nitrogen*, in which the *nitrogen is combined with carbon*. This is the form in which nitrogen is taken by animals, either directly from vegetable food—more particularly from green vegetables—or in flesh-feeding animals, partly as above and partly in the form of lean meat. The organic compounds of nitrogen after the death of the animal or plant furnish the food of the *nitrifying bacteria*, which assist in the work of splitting up these compounds, sending off the carbon as carbonic acid, and leaving the nitrogen, first in combination with hydrogen, and afterward oxidizing the nitrogen to the form of a nitrate.—*Knowledge*.

TESTS FOR COCOANUT AND PALM OIL.

THE following scheme to detect the adulteration of these oils with others may be used:

First operation.—28 c. c. of the sample are shaken for one minute in a graduated tube with 40 c. c. of alcohol of 90°, when the oil, deprived of its free fatty acids, sinks to the bottom. Alcohol of 85° then absorbs a certain quantity of neutral fatty matters, and the oil dissolves 15 to 20 per cent. of alcohol. The solvent power of the oil diminishes sensibly in the presence of insoluble oils, while that of the alcohol increases in the presence of oils soluble in alcohol of 95°, castor oil, resin oil, etc., which latter can be readily characterized by their physical and chemical properties.

Second operation.—5 c. c. of cocoanut oil, previously washed with alcohol of 95°, are treated in a graduated tube with 10 c. c. of absolute alcohol, and the mixture placed on the water bath at 30° to 31° C.; it is now shaken for 40 seconds and replaced on the water bath. Pure cocoanut oil dissolves completely under these conditions, while contaminated with oils insoluble in alcohol, such as earth nut, sesame, cottonseed, and maize oils, it does not sensibly dissolve, but falls to the bottom of the tube. Cocoanut oil containing 20 per cent. of palm oil separates, but when the percentage is below this a turbid emulsion results. Palm oil is treated in the same manner, only with 20 c. c. instead of 10 c. c. of absolute alcohol. Five c. c. of palm oil containing 20 per cent. and upward of cocoanut oil is soluble in 15 c. c. of absolute alcohol, while under these circumstances the pure oil forms a turbid emulsion.

The purity of cocoanut and palm oil cakes is determined by extracting the fats and treating them in the manner above described.

The volatile fatty acids in butter fat may be estimated thus:

Five grammes of filtered dry butter fat is placed in a flask of 300 to 350 c. c. capacity, and 2 c. c. of 50 per cent. aqueous soda and 20 c. c. of glycerol added. The mixture is then carefully boiled over wire gauze, until all the water is expelled, the flask being gently rotated the while; the heating is then continued with a smaller flame; in 15 min. a clear soap solution is obtained, which after cooling is mixed with 90 c. c. of water and 50 c. c. of dilute sulphuric acid (50 c. c. of acid per liter), some fragments of pumice added, and the mixture distilled until 110 c. c. has passed over. The author regards the method as quicker and more convenient than the older methods, but the test analysis appears to be far from satisfactory.

Baudouin's test for sesame oil in olive oil is applied as follows:

0·1 gramme of sugar is dissolved in a test tube in 10 c. c. HCl, sp. gr. 1·19; 20 c.c. of the sample of olive oil is then added, the whole thoroughly shaken for a minute, and allowed to settle.

If the oil is pure the acid and oils retain their original color, but if sesame oil is present, they are both of a decidedly reddish shade.

[Continued from SUPPLEMENT, No. 946, page 15126.]

ALLOYS.*

By Prof. W. CHANDLER ROBERTS-AUSTEN, C.B., F.R.S.

Lecture IV.†

IT seems to me that much Japanese work presents singular analogies to that of the Italian Renaissance, and the second of the two works for which I have claimed special admiration is, fortunately, in our own collection in the South Kensington Museum. It is the wonderful incense holder, with peacocks and pigeons in ordinary colored bronze exquisitely modeled, and the casting must have been effected by the method of *cire perdue*. A brief description of the method of casting will be given subsequently. This incense holder is the work of Chokichi Kako, and it was exhibited in the Japanese section of the Paris exhibition of 1878. I hope it will be one of the next objects we shall be permitted to analyze, but I do not anticipate that it will differ much from characteristic Japanese bronzes, though it probably contains less lead than the bronze tortoise, of which analysis is given. Fifteen years have elapsed since then—a long period in the life of a Japanese; but the same artist is again represented at Chicago, this time with an even more important work. He has designed a series of twelve falcons, birds which have long been held in high esteem in Japan. The varieties of plumage have given the artist free scope for all manner of dexterous experiments with the various alloys and patinas, in the use of which the Japanese have no rivals. The birds have been produced by the *cire perdue* process, and colored by pickling. Upon one a tone of yellow and green gold has been arrived at; another is in a brown alloy; another, in black shakudo, glistens with wet; while yet another is of unpolished silver. Few birds present such delicate gradations in grays and browns; but these tints are admirably caught: while each bird is depicted in some characteristic attitude, which only lengthened study of the original has enabled the artist to convey.

Specimens of ancient bronze analyzed by E. J. Maumene‡ gave the following results:

	I.	II.	III.	IV.
Copper	86·38	80·91	88·70	92·07
Tin	1·94	7·55	2·58	1·04
Antimony	1·61	0·44	0·10	—
Lead	5·68	5·33	3·54	—
Zinc	3·36	3·08	3·71	2·65
Iron	0·67	1·43	1·07	3·64
Manganese	—	trace	—	—
Silica	0·10	0·16	0·09	0·04
Sulphur	—	0·31	—	—
	99·74	90·21	99·79	99·44

Mr. Alfred Gilbert, A.R.A., the excellence of whose mental castings is well known, considers that the following composition is very suitable for casting by the *cire perdue* methods:

Copper	91·40
Tin	5·70
Lead	2·90
	100·00

H. Morin§ has shown that the black patina of certain Oriental bronzes is due to the presence of lead, and MM. Christofle and Bouilliet‖ confirm this view, but state that the patinas may be produced of a wide range of tint on pure electrolytic copper by the use of suitable reagents, and although they provokingly refrain from "disclosing" what these reagents are, they say that the tint is due to two different molecular states of cuprous oxide.

Now doubtless the artificial patina is, to a considerable extent, more dependent on the nature of the pickling than on the composition of the copper alloy used, but it is nevertheless true that there are solutions which give a varied range of tints if the compositions of the copper be altered but a little.

It would, at first sight, appear to be useless in London to think of composing bronze so as to give a pure patina. Take, for instance, one of our last erected monuments—the equestrian statue of Lord Napier of Magdala, which is placed opposite the Guards Memorial in Waterloo Place. A few months ago the patina began to form, and iridescent tints played over his features, and unsightly rain stains ran down his horse; now the layer is thickening, and gray brown tint deepening, but there is no velvety brown of oxide, or green and blue of carbonate. The soldier, field glass in hand, is sternly looking away from the Athenæum and the learned societies, as if conscious that, in the present state of the London atmosphere, he was beyond the aid of science, for science has clearly stated that, so long as bituminous coal is burnt in open fireplaces, London must be smoky, and man and horse alike will soon be covered with the black pall of soot and sulphide of copper which now enshrouds the unfortunate occupants of adjoining pedestals, Franklin and Lord Clyde.

In Mr. Alfred Gilbert's monumental fountain, in memory of the late Lord Shaftesbury, which is placed at the Piccadilly end of Shaftsbury Avenue, an at-

* Lectures delivered before the Society of Arts, London, 1893. From the Journal of the Society.

† Some of the particulars contained in this lecture were given in a lecture delivered at South Kensington Museum in 1892, and some portions, relating to Japanese art metal work, formed the subject of a paper read before the Applied Art Section of this Society, which appeared in the *Journal* June 30, 1890.

‡ "Comptes Rendus," lxxx., 1875, p. 1009.

§ "Comptes Rendus," vol. 78, 1874. 811.

‖ Ibid., 1019.

tempt has been made to enrich the composition by the sparing use of colored patina among the marvelously beautiful details of the work, the metal itself nearly approaching, I believe, gun metal in composition. A winged aluminum figure, moreover, surmounts the structure, and the effect of weather upon it will be watched with great interest. But can nothing be done to preserve our statues in the atmosphere of London? Much, I am satisfied, may be done. When the metal has once obtained a coating of patina, it should be carefully wiped, to remove extraneous deposits of soot. Look at the paws and flanks of the sphinxes which guard Cleopatra's Needle on the Embankment. In the evenings they form a center of attraction for the London children, and the more adventurous clamber over the beasts and slide down their haunches, the dark patina of which has become beautifully polished, although there does not appear to be any wear of the finer details of the modeling. When Trafalgar Square was more used as a meeting place than it is now, and when the base of Nelson's column served as a rostrum, the paws of the lion were beautiful in their lustrous polish over the dark patina; and in several London decorative works in bronze unexpected patches of polished patina are to be seen, which owe their luster to the fact that they form a convenient rest to some lounging *habitue* of the spot. The polish on the lions in Trafalgar Square, and on the sphinxes on the Embankment, afford the best indication of what might be done by careful wiping, and deserve attention as examples of the unconscious services to art which have been rendered by the agitator and the "arab."

I have finished with the bronzes for the present, and will turn to a singular group of alloys in which the copper and tin are subordinated to zinc itself, and these alloys are well illustrated by the Indian *bidri* wares.

The *bidri* objects, Nos. 36 to 39, are a peculiar series of alloys. They are chiefly zinc containing a quantity of copper and lead, with smaller amounts of tin and iron. The amount of lead in No. 37 is remarkably low, and, as it is very difficult to purify zinc from lead, it would appear that a very pure ore of zinc must have been used in the preparation of this metal. Apparently copper is the predominating metal associated with zinc in this *bidri* alloy. From this it is probable that No. 38, which contains none of it, is not Indian, but Hungarian, as the museum description suggests. In the other specimen, to which a doubtful origin is assigned (No. 39), copper is present, but in small proportion, tin being the secondary metal. This indicates that it is not Indian.

These works are beautifully damascened with silver in the form of thin plates, which are let in to undercut depressions in the surface of the metal of which the objects are made. It then takes a fine dark color by exposure and tarnish.

No. 36.—Ewer, with cover. Oxidized metal, damascened with silver. *Indian*, modern. H. 2 ft. 11 in., diam. 2 ft. 4 in. Given by her Majesty the Queen. 587.—'54.

Analysis.

Lead	1·298
Copper	3·510
Iron	0·049
Silver	nil
Zinc, by diff	95·143
	100·000

No. 38.—Bottle, with cover. Metal, with raised chasing of flower and leaf pattern, covered with gold and silver foil. *Hungarian* or *Indian*. Latter half of seventeenth century. H. 14⅜ in., diam. 5⅞ in.

Analysis.

Lead	0·956
Tin	0·346
Iron	0·084
Copper	nil
	1·386
Zinc, by diff	98·614

No. 38A.—Vase. Oxidized metal, damascened with silver. *Indian*, modern. H. 23 in., diam. 22 in. Given by her Majesty the Queen. 585.—'54.

Analysis.

Lead	1·437
Tin	trace
Iron	0·039
Copper	6·905
	8·381
Zinc, by diff	91·619

A singular case in which bronze, brass and a little gold are combined has already been described in a lecture delivered before this society, on "Alloys Used in Art Metal Work."

No. 54.—Hanuman; the monkey ally of *Rama*; copper and brass, cut through to show process of casting. *Madras*. Modern. H. 4 in.—726.

This specimen of art metal work is of peculiar interest, insomuch as it was apparently a compound casting showing on its surface two distinct metals, viz., bronze and brass very much interspersed. The figure was not of one metal altered in color in parts by superficial treatment, as inspection showed the color to be due to the metal itself. Owing to the intermixture of the metals—the way in which they protruded one beyond the other at different points, and the small quantity at parts of one metal over the other, such as the bracelets, armlets, for example—it was difficult to understand from outside examination how these figures were made. With the object of solving the question, it was considered that some light might be thrown on the subject if the casting were cut in halves from top to bottom. This was done, and immediately the whole process was explained, as it is quite clear that a core of copper was originally cast, of a shape showing due regard to the result desired, and that the brass was cast round the copper.

From what is known in connection with small Oriental castings, it is probable that the following process has been employed in the production of these double castings. First, a model has been carved in wax, of a shape and size necessary to bring out the copper where that metal is required at the surface, and leaving space where the yellow surface is desired for the future casting of brass. This wax model has then been moulded, the mould heated and the wax melted out, after which the copper has been cast in the mould. Then around this half figure, with its prominent parts, where necessary, more wax has been cast, and carved into the shape of the figure ultimately required. The whole has then been moulded, the wax removed as before, and the brass run into the mould, filling up the spaces existing between it and the copper core in the center. The double casting has then been removed, the brass filed down, wherever it might accidentally and unnecessarily have covered the copper, until the red metal was exposed, the whole being then chased and completed.

This casting is probably about 40 years old, and was made in Madras. The art of double casting, as represented by this figure, is very old (a thousand years or more), and has been practiced at, and almost entirely confined to, the east coast of the Madras Presidency.

Mr. Havell, of the School of Art of Madras, who has been engaged on a survey of art manufactures for the government, reported in 1887 that these castings were no longer made. Mr. C. Purdon Clarke thinks that if this be true, it is probably due to the high cost of production.

The rest of my remarks will be mainly devoted to the questions of patina and texture. The standard fineness of gold and silver wares is, as is well known, vigorously guarded by law, and articles of gold may only vary between the limits of 9 carats, or 37·5 per cent., and 22 carats, 91·66 per cent. of the precious metal, while silverwork always contains 92·5 per cent. of silver. In the latter case, the rigid adherence to the old standard of England, while securing integrity in the productions of the silversmiths, has, it is to be feared, exerted a prejudicial influence on the development of metal work. In this custom has much to answer for: we have become so accustomed to see wares of the precious metals with resplendent surfaces, that the public will barely tolerate, and certainly do not appreciate, the film of varnish which silver acquires when exposed to the atmosphere; we seem to have entirely shut ourselves out from the use of a large series of alloys, the beauty of which depends on the tarnish they gain, either by time or exposure, or by the far more rapid action of chemical agents.

Take the case of "presentation plate"—quite apart from the terrible examples presented by many of the articles which generally serve for this purpose—the question of weight always receives attention; the price is not paid for the craftsmanship, but the weight, the number of ounces, and not the originality of treatment, too often considered to be far more important in determining the choice. In the case of metal work we have been warned that such absence of "perception is fraught with infinite mischief, direct or indirect, to the development of art among us, tending as it does to divorce from it whole classes of industrial production, and incalculably narrowing the field of beauty in our lives."* The law is in no small measure responsible for the limitation of material, as the use of varied alloys in silver work is forbidden, so that the very restrictions which in the past have secured honesty in work have been fatal to progress in art.

(*To be continued.*)

* Sir Frederick Leighton.

ANALYSIS OF SMOKELESS POWDER.

By C. ISTRATI.

THERE is nothing more difficult than to have to analyze a complex substance of the composition of which one has not the slightest idea. Especially is this so when the compound is explosive, as the case with a smokeless powder. In any case it is necessary to make a preliminary analysis, and to first endeavor to split the body into less complex bodies of which to make a qualitative analysis. Even then there remains the difficulty of estimating the relative quantities in which these bodies occur. Such a case, however, fell to my lot, having to analyze a smokeless powder concerning the composition of which I had not the slightest idea, and was, therefore, somewhat exercised as to how to proceed, and did not think I should succeed in finding out as easily as I did the composition of the powder I had to investigate.

This powder was in the form of small sticks, perfectly cylindrical, their diameter being less than a millimeter and their length about seven millimeters. The color was yellow, with a waxy appearance, and sufficiently soft to be easily squashed under one's finger nail. It burnt without explosion, and at the rate of about a meter in four minutes, the little cylinders being placed end on end. The powder was not soluble at all in water, and when burnt it left very little ash.

Dried at 105° C., it gave upon analysis the following results:

	Per cent.
Carbon	21·86
Hydrogen	3·33
Nitrogen	15·84

Some of the powder was then placed in an extraction apparatus and extracted with benzine. After several trials it was found that by this treatment the powder was only separated into two parts, which by their intimate mixture formed the greater part of the powder; with the exception that a small quantity of resin was found, about 0·5 per cent., with which the cylinders were probably covered to prevent their absorbing moisture from the air.

Of the two portions obtained by the benzine treatment, one was a colorless liquid which exploded when struck with a hammer, and was found to be nitro-glycerine. The other part was a light gray solid, which on analysis was found to be trinitro-cellulose, and to which the powder owed its inflammable properties. The results of the estimation of the percentage of these two ingredients were as follows:

	Per cent.
Nitro-glycerine	48·00
Trinitro-cellulose	51·50
Resin	0·50
	100·00

The resin only being added to form a protecting covering and to give adhesiveness to the particles.—*Bul. Soc. Sci. Bucuresci.*

[FROM THE AMERICAN JOURNAL OF SCIENCE.]

THE INTERNAL WORK OF THE WIND.*

By S. P. LANGLEY.

PART III.—APPLICATION.

OF these irregular movements of the wind, which take place up, down, and on every side, and are accompanied of necessity by equally complex condensations and expansions, it will be observed that only a small portion, namely, those which occur in a narrow current whose direction is horizontal and sensibly linear, and whose width is only the diameter of the anemometer, can be noted by the instruments I have here described, and whose records alone are represented in the diagram. However complex the movement may appear as shown by the diagram, it is then far less so than the reality, and it is probable, indeed, that anything like a fairly complete graphical presentation of the case is impossible.

I think that on considering these striking curves (Figs. 1, 2, 3, 4 and 5) we shall not find it difficult to admit, at least as an abstract conception, that there is no necessary violation of the principle of the conservation of energy implied in the admission that a body wholly immersed in and moving with such a wind may derive from it a force which may be utilized in *lifting* the body, in a way in which a body immersed in the "wind" of our ordinary conception could not be lifted, and if we admit that the body may be lifted, it follows obviously that it may descend under the action of gravity from the elevated position, on a sloping path, to some distance in a direction opposed to that of the wind which lifted it, though it is not obvious what this distance is.

We may admit all this, because we now see (I repeat) that the apparent violation of law arises from a tacit assumption which we, in common with all others, may have made, that the wind is an approximately homogeneously moving body, because moving as a whole in one direction. It is, on the contrary, *always*, as we see here, filled (even if we consider only movements in some one horizontal plane) with amazingly complex motions, some of which, if not in direct opposition to the main movement, are relatively so, that is, are slower, while others are faster than this main movement, so that a portion is always opposed to it.

From this, then, we may now at least see that it is plainly within the capacity of an intelligence like that suggested by Maxwell, and which Lord Kelvin has called the "Sorting Demon," to pick out from the internal motions those whose direction is opposed to the main current, and to omit those which are not so, and thus *without the expenditure of energy* to construct a force which will act against the main current itself.

But we may go materially further, and not only admit that it is not necessary to invoke here, as Maxwell has done in the case of thermo-dynamics, a being having power and rapidity of action far above ours, but that in actual fact, a being of a lower order than ourselves, guided only by instinct, may so utilize these internal motions.

We might not indeed have conceived this possible, were it not that nature has already, to a large extent, exhibited it before our eyes in the soaring bird which sustains itself endlessly in the air with nearly motionless wings, for without this evidence of the possibility of an action which now ceases to approach the inconceivable, we are not likely, even if admitting its theoretical possibility, to have thought the mechanical solution of this problem possible.

But although to show how this physical miracle of nature is to be imitated, completely and in detail, may be found to transcend any power of analysis, I hope to show that this may be possible without invoking the asserted power of "aspiration" relative to curved surfaces, or the trend of upward currents, and even to indicate the probability that the mechanical solution of this problem may not be beyond human skill.

To this conclusion we are invited by the following consideration, among others.

We will presently examine the means of utilizing this potentiality of internal work in order to cause an inert body wholly unrestricted in its motion and wholly immersed in the current, to *rise*; but first let us consider such a body (a plane) whose movement is restricted to a horizontal direction, but which is free to move between frictionless vertical guides. Let it be inclined upward at a small angle toward a horizontal wind, so that only the vertical component of the pressure of the wind on the plane will affect its motion. If the velocity of the wind be sufficient, the vertical component of pressure will equal or exceed the weight of the plane, and in the latter case, the plane will rise indefinitely.

* A paper read (by title only) to the National Academy of Sciences, in April, 1893, and subsequently (in full) at the Aeronautical Congress at Chicago, August, 1893.—[Continued from SUPPLEMENT No. 946, page 15124.]

† "When the condors in a flock are wheeling round and round any spot, their flight is beautiful. Except when rising from the ground, I do not recollect ever having seen one of these birds flap its wings. Near Lima, I watched several for nearly half an hour without once taking off my eyes. They moved in large curves sweeping in circles, descending and ascending without once flapping. As they glided close over my head, I intently watched, from an oblique position, the outlines of the separate and terminal feathers of the wing; and if there had been the least vibratory movement these would have blended together, but they were seen distinct against the blue sky. The head and neck were moved frequently and apparently with force, and it appeared as if the extended wings formed the fulcrum on which the movements of the neck, body, and tail acted. If the bird wished to descend, the wings for a moment collapsed; and then when again expanded with an altered inclination the momentum gained by the rapid descent seemed to urge the bird upward, with the even and steady movement of a paper kite. In the case of any bird *soaring*, its motion must be sufficiently rapid so that the action of the inclined surface of its body on the atmosphere may counterbalance its gravity. The force to keep up the momentum of a body moving in a horizontal plane in that fluid (in which there is so little friction) cannot be great, and this force is all that is wanted. The movement of the neck and body of the condor, we must suppose, is sufficient for this. However this may be, it is truly wonderful and beautiful to see so great a bird, hour after hour, without any apparent exertion, wheeling and gliding over mountain and river."—Darwin's *Journal of the Various Countries Visited by H. M. S. Beagle*, pp. 223, 224.

Thus to take a concrete example, if the plane be a rectangle whose length is six times its width, having an area of 2·3 square feet to the pound, and be inclined at an angle of 7°, and if the wind have a velocity of 36 feet per second, experiment shows that the upward pressure will exceed the weight of the plane, and the plane will rise, if between vertical nearly frictionless guides, at an increasing rate, until it has a velocity of 2·52 feet per second,* at which speed the weight and upward pressure are in equilibrium. Hence there are no unbalanced forces acting, and the plane will have attained a state of uniform motion.

For a wind that blows during 10 seconds, the plane will therefore rise about 25 feet. At the beginning of the motion, the inertia of the plane makes the rate of rise less than the uniform rate, but at the end of 10 seconds, the inertia will cause the plane to ascend a short distance after the wind has ceased, so that the deficit at the beginning will be counterbalanced by the excess at the end of the assigned interval.

We have just been speaking of a material heavy plane permanently sustained in vertical guides, which are essential to its continuous ascent in a uniform wind, but such a plane will be lifted and sustained *momentarily* even if there be no vertical guides, or in the case of a kite, even if there be no cord to retain it, the inertia of the body supplying for a brief period the office of the guides or of the cord. If suitably disposed, it will, as the writer has elsewhere shown, under the resistance to a horizontal wind, imposed only by its inertia, commence to move, not in the direction of the wind, but nearly vertically. Presently, however, as we recognize, this inertia must be overcome, and as the inclined plane takes up more and more the motion of the wind, the lifting effect must grow less and less (that is to say, if the wind be the approximately homogeneous current it is commonly treated as being), and finally ceasing altogether, the plane must ultimately fall. If, however, a counter current is supposed to meet this inclined plane, before the effect of its inertia is exhausted, and consequently before it ceases to rise, we have only to suppose the plane to be rotated through 180° about a vertical axis, without any other call for the expenditure of energy, to see that it will now be lifted still higher, owing to the fact that its inertia now reappears as an active factor. The annexed sketch (Fig. 6) shows a typical representation

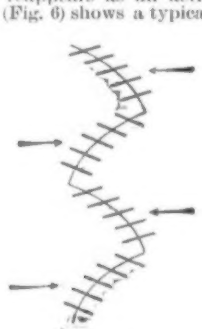


FIG. 6.

of what might be supposed to happen with a model inclined plane freely suspended in the air, and endowed with the power of rotating about a vertical axis so as to change the aspect of its constant inclination, which need involve no (theoretical) expenditure of energy, even although the plane possess inertia. We see that this plate would rise indefinitely by the action of the wind in alternate *directions*.

The disposition of the wind which is here supposed to cause the plane to rise, appears at first sight an impossible one, but we shall next make the important observation that it becomes virtually possible by a method which we will now point out, and which leads to a practicable one which we may actually employ.

Fig. 7 shows the wind blowing in one constant direc-

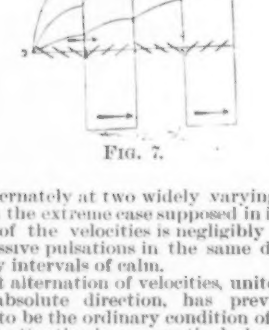


FIG. 7.

tion, but alternately at two widely varying velocities, or rather (in the extreme case supposed in illustration), where one of the velocities is negligibly small, and where successive pulsations in the same direction are separated by intervals of calm.

A frequent alternation of velocities, united with constancy of absolute direction, has previously been shown here to be the ordinary condition of the wind's motion; but attention is now particularly called to the fact that while these unequal velocities may be in the same direction as regards the surface of the earth, yet as regards the *mean* motion of the wind they are in opposite directions, and will produce on a plane, whose inertia enables it to sustain a sensibly uniform motion with the mean velocity of this variable wind, the same lifting effect as if these same alternating winds were in absolutely opposed directions, provided that the constant inclination of the plane alternates in its aspect to correspond with the changes in the wind.

It may aid in clearness of conception, if we imagine a set of fixed co-ordinates, X Y Z, passing through 0, and a set of movable co-ordinates, $x\ y\ z$, moving with the velocity and the direction of the mean wind. If the moving body is referred to these first only, it is evidently subject to pulsations which take place in the same directions on the axis of X, but it must be also evident that it referred to the second or movable co-ordinates, these same pulsations may be and are in opposite directions. This, then, is the case we have just considered, and if we suppose the plane to change the aspect* of its (constant) inclination as the direction of the pulsations changes, it is evident that there must be a gain in altitude with every pulsation, while the plane advances horizontally with the velocity of the mean wind.

During the period of maximum wind velocity, when the wind is moving faster than the plane, the rear edge of the latter must be elevated. During the period of minimum velocity, when the plane, owing to its inertia, is moving faster than the wind, the front edge of the plane must be elevated. Thus the vertical component of the wind pressure, as it strikes the oblique plane, tends in both cases to give it a vertical upward thrust. So long as this thrust is in excess of the weight to be lifted, the plane will rise. The rate of rise will be greatest at the beginning of each period, when the relative velocity is greatest, and will diminish as the resistance produces "drift," *i. e.*, diminishes relative velocity. The curved line, O B, in the vignette, represents a typical path of the plane under these conditions.

It follows from the diagram (Fig. 6) that, other things being equal, the more frequent the wind's pulsations, the greater will be the rise of the plane, for since during each period of steady wind, the rate of rise diminishes, the more rapid the pulsations, the nearer the mean rate of rise will be to the initial rate. The requisite frequency of pulsations is also related to the inertia of the plane, as the less the inertia, the more frequent must be the pulsations, in order that the plane shall not lose its relative velocity.

It is obvious that there is a limit or weight which cannot be exceeded if the body is to be sustained by any such fluctuations of velocity as can be actually experienced. Above this limit of weight the body will sink. Below this limit the lighter the body is the higher it will be carried, but with increasing variability of speed. That body, then, which has the greatest weight per unit of surface will soar with the greatest steadiness, if it soar at all, not on account of this weight *per se*, but because the weight is an index of its inertia.

The reader who will compare the results of experiments made with any artificial flying models, like those of Penaud, with the weights of the soaring birds, as given in the tables by M. Mouillard, or other authentic sources, cannot fail to be struck with the great weight in proportion to wing surface which nature has given to the soaring bird, compared with any which man has yet been able to imitate in his models.

This fact of the weight of the soaring bird in proportion to its area has been again and again noted, and it has been frequently remarked that without weight the bird could not soar by writers who felt that they could very safely make such a paradoxical statement, in view of the evidence nature everywhere gave that this weight was indeed in some way necessary to rising. But these writers have not shown, so far as I remember, how this necessity arises, and this is what I now endeavor to point out.†

It has not here been shown what limit of weight is imposed to the power of an ordinary wind to elevate and sustain, but it seems to me, and I hope that it may seem to the reader, that the evidence that there is *some* weight which the action of the wind is sufficient to permanently sustain under these conditions in a free body has a demonstrative character, although no quantitative formula is offered at this stage of the investigation. It is obvious that, if this weight is sustainable at any height, gravity may be utilized to cause the body (which we suppose to be a material plane) to descend on an inclined course to some distance, even against the wind.

I desire in this connection to remark that the preceding experiments and deductions showing that a material free plane,‡ possessing sufficient inertia, may, in theory, rise indefinitely by the action of an ordinary wind, without the expenditure of work from any internal source (as well as those statements which follow), when these explanations are once made, have a character of obviousness, which is due to the simplicity of the enunciation, but not, I think, to the familiarity of the explanation, for though attention is beginning to be paid by meteorologists to the rapidity of these wind fluctuations, I am not aware that their effects have been so exhibited, or especially that they have been presented in this connection, or that the conclusions which follow have been drawn from them.

We have here seen, then, how pulsations of sufficient amplitude and frequency, of the kind which present themselves in nature, may, in theory, furnish energy not only sufficient to sustain, but actually to elevate a heavy body moving in and with the wind at its mean rate.

It is easy to now pass to the practical case, which has been already referred to, and which is exemplified in nature, namely, that in which the body (*e. g.*, the bird soaring on rigid wings, but having power to change its inclination) uses the elevation thus gained to move against the wind without expending any sensible amount of its own energy. Here the upward motion is designedly arrested at any convenient stage, *e. g.*, at each alternate pulsation of the wind, and the height attained is utilized so that the action of gravity may carry the body by its descent in a curvilinear path (if necessary) against the wind. It has just been pointed out that if some height has been attained, the theoretical possibility of *some* advance against the wind in so falling hardly needs demonstration, although it may not unnaturally be supposed that the relative advance so gained must be insignificant compared with the distance traveled by the mean wind while the body was being elevated, so that on the whole the body is carried by the wind further than it advances against it.

This, however, probably need not be, in fact, the case, there being, as it appears to me from experiment and from deduction, every reason to believe that under suitable conditions the advance may be greater than the recession, or that the body falling under the action of gravity along a suitable path may return against the wind, not only from Z to O, the point of departure, but further, as is here shown.

I repeat, however, that I am not at the moment undertaking to demonstrate how the action is mechanically realizable in actual practice, but only that it is possible. It is for this purpose and to understand more exactly that it can be effected, not only by the process indicated in Fig. 7, but by another and probably more usual one (and nature has still others at command), that I have considered another treatment of the same conditions, of wind pulsations always moving in the same horizontal direction, but for brief periods, interrupted by equal intervals of calm. In Fig. 8 we sup-

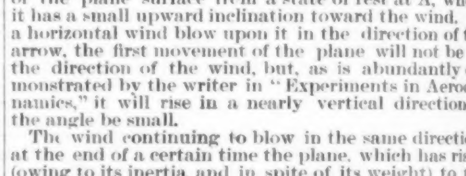


FIG. 8.

pose the body to use the height gained in each pulsation, to enable it to descend after each such pulsation and advance against the direction of the wind.

The portion, A B, of the curve represents the path of the plane surface from a state of rest at A, where it has a small upward inclination toward the wind. If a horizontal wind blow upon it in the direction of the arrow, the first movement of the plane will not be in the direction of the wind, but, as is abundantly demonstrated by the writer in "Experiments in Aerodynamics," it will rise in a nearly vertical direction, if the angle be small.

The wind continuing to blow in the same direction, at the end of a certain time the plane, which has risen (owing to its inertia and in spite of its weight) to the successive positions shown, is taking up more and more of the horizontal velocity of the wind and consequently opposing less resistance to it, and therefore moving more and more laterally and rising less and less at every successive instant.

If the wind continued indefinitely, the plane would ultimately take up its velocity, and finally, of course, fall when this inertia ceased to oppose resistance to the wind's advance. I have supposed, however, the wind pulsation to cease at the end of a certain brief period, and, to fix our ideas, let us suppose this period to be five seconds. At this moment the period of calms begins, and now let the plane, which is supposed to have reached the point, B, change its inclination about a horizontal axis to that shown in the diagram, falling at first nearly vertically, with its edge on the line of its descent, so as to acquire speed, and, this speed acquired, by constantly changing its angle, glide down the curve, B *b* C, so that the plane shall be tangential to it at every point of its descending advance. At the end of five seconds of calm it has reached the position, C, near the lowest point of its descent, which there is no contradiction to known mechanical laws in supposing *may* be higher than A, and which, in fact, according to the most accurate data the writer can gather, *is* higher in the case of the above period and in the case of such an actual plane as has been experimented upon by him.

Now, having reached C, at the end of the five seconds' calm, if the wind blow in the same direction and velocity as before, it will again elevate the plane on the latter's presenting the proper angle, but this time under more favorable circumstances, for at this time the plane is already in motion in a direction opposed to that of the wind, and is already higher than it was in its original position, A. Its course, therefore, will be nearly that along the curve, C D, during all which time it maintains the original angle, *a*, or one very slightly less. Arrived at D, and at the instant when the calm begins, it falls with varying inclination to the lowest position, E (which may be higher than C), which it attains at the end of the five seconds of calm, then rises again (still nearly at the angle, *a*), to a higher position, and so on; the alternation of directions of motion, at the end of each pulsation, growing less and less sharp, and the path finally taking the character of a sinuous curve. We have assumed that the plane goes against the wind and rises at the same time, in order to illustrate that this is possible, though either alternative may be employed, and the plane, in theory at least, may maintain, on the whole, a rapid and nearly horizontal, or a slow and nearly vertical course, or anything between.

It is not meant, either, that the alternations which would be observed in nature are as sharp as those here represented, which are intentionally exaggerated, while in all which has just preceded, by an equally intentional exaggeration of the normal action, the wind pulsations have been supposed to alternate with absolute calm. This being understood, it is scarcely necessary to point out that if the calm is not absolute, but if there are simply frequent successive winds or pulsations of wind of considerably differing velocity (such as the anemometer observations show are realized in nature), that the same general effect will obtain.*

* See "Experiments in Aerodynamics," by S. P. Langley, *Smithsonian Contributions to Knowledge*, 1891.

* We do not for the moment consider how this change of aspect is to be mechanically effected; we only at present call attention to the fact that it involves, in theory, no expenditures of energy.

† It is, perhaps, not superfluous to recall here that, according to the researches of Rankine, Froude and others, a body moulded in wave line curves would, if frictionless, continue to move indefinitely against an opposed wind in virtue of inertia and once acquired velocity, and also to recall how very small the effect of fluid friction in the air has been shown to be (by the writer in a previous investigation).

‡ I use the word "plane," but include in the statement all suitable modifications of a curved surface.

I desire to recall attention to the paragraph in "Experiments in Aerodynamics," in which I caution the reader against supposing that by investigating plane surfaces I imply that they are the best form of surface for flight; and I repeat here that, as a matter of fact, I do not believe them to be so. I have selected the plane simply as the best form for preliminary experiment.

* The rotation of the body about a vertical axis so as to change the aspect of the inclination as in the first figure, may be illustrated by the wh

though we are not entitled to assume from any demonstration thus far given that the total advance will be necessarily greater than that of the whole distance the mean wind has traveled. It may also be observed that the actual actions of the soaring bird may be and doubtless are more complex in detail than those of this diagram, while yet in their entirety depending on the principles it sets forth.

The theoretical possibility, at least, will now, it is hoped, be granted, not only of the body's rising indefinitely, or of its descending in the interval of calm to a higher level, C, than it rose from at A, but of its advancing against the calm or light wind through a distance, B C, greater than that of A B, and so on. The writer, however, repeats that he has reason to suppose from the data obtained by him, that this is not only a theoretical possibility, but a mechanical probability under the conditions stated, although he does not here offer a quantitative demonstration of the fact, other than by pointing to the movements of the soaring bird and inviting their reconsideration in the light of the preceding statements.

The bird, by some tactile sensibility to the pressure and direction of the air, is able, in nautical phrase, to "see the wind,"* and to time its movements, so that without any reference to its height from the ground, it reaches the lowest portion of its descent near the end of the more rapid wind pulsation. But the writer believes that to cause these adaptive changes in an otherwise inert body, with what might almost be called instinctive readiness and rapidity, does not really demand intelligence or even instinct, but that the future aerodrome may be furnished with a substitute for instinct in what may, perhaps, allowably be called a mechanical brain, which yet need not, in his opinion, be intricate in its character. His reasons for this statement, which is not made lightly, must, however, be reserved for another time.

It is hardly necessary to point out that the nearly inert body in question may also be a human body, guided both by instinct and intelligence, and that there may thus be a sense in which human flight may be possible, although flight depending wholly upon the action of human muscles be forever impossible.

Let me resume the leading points of the present memoir in the statement that it has been shown:

(1) That the wind is not even an approximately uniform moving mass of air, but consists of a succession of very brief pulsations of varying amplitude, and that, relatively to the mean movement of the wind, these are of varying direction.

(2) That it is pointed out that hence there is a potentiality of "internal work" in the wind, and probably of a very great amount.

(3) That it involves no contradiction of known principles to declare that an inclined plane, or suitably curved surface, heavier than the air, freely immersed in, and moving with the velocity of the mean wind, can, if the wind pulsations here described are of sufficient amplitude and frequency, be sustained or even raised indefinitely without expenditure of internal energy other than that which is involved in changing the aspect of its inclination at each pulsation.

(4) That since (A) such a surface, having also power to change its inclination, *must* gain energy through falling during the slower and expend energy by rising during the higher velocities; and that (B) since it has been shown that there is no contradiction of known mechanical laws in assuming that the surface *may* be sustained or *may* continue to rise indefinitely, the mechanical possibility of some advance against the direction of the wind follows immediately from this capacity of rising. It is further seen that it is at least possible that this advance against the wind may not only be attained relatively to the position of a body moving with the speed of the mean wind, but absolutely, and with reference to a fixed point in space.

(5) The statement is made that this is not only mechanically possible, but that in the writer's opinion, it is realizable in practice.

Finally, these observations and deductions have, it seems to me, an important practical application, not only as regards a living creature like the soaring bird, but still more as regards a mechanically-constructed body, whose specific gravity may probably be many hundred or even many thousand times that of the atmosphere. We may suppose such a body to be supplied with fuel and engines, which would be indispensable to sustain it in a calm, and yet which we now see might be ordinarily left entirely inactive, so that the body could supposably remain in the air and even maintain its motion in any direction without expending its energy, except as regards the act of changing the inclination or aspect which it presents to the wind, while the wind blew.

The final application of these principles to the art of aerodromics seem to be that while it is not likely that the perfected aerodrome will ever be able to dispense altogether with the ability to rely at intervals on some internal source of power, it will not be indispensable that this aerodrome of the future shall, in order to go any distance—even to circumnavigate the globe without alighting—need to carry a weight of fuel, which would enable it to perform this journey under conditions analogous to those of a steamship, but that the fuel and weight need only be such as to enable it to take care of itself in exceptional moments of calm.

Smithsonian Institution, Washington, D. C., August, 1893.

known habit of many soaring birds of moving in small closed curves or spirals, but it may also be observed, in view of the fact that even in intervals of relative calm during which the body descends, there is always some wind; that in making the descents, if the body, animate or inanimate, maintain its direct advance, this wind tends to strike on the upper side of the plane or pinion. Mr. G. E. Curtis offers the suggestion that the soaring bird avoids such a position when possible, and therefore turns at right angles to or with the wind, and that this may be an additional reason for his well-known habit of moving in spirals.

* Mouillard.

"THOSE COCOONS RESEMBLING PINE CONES?"

By Prof. C. V. RILEY.

MR. JAMES WEIR, Jr.'s, article on "Pine Cones, or Cocoons?" in the SCIENTIFIC AMERICAN for January 20, 1894, is interesting, and his figures show that there is a very slight resemblance between the bags of the bag worm (*Thyridopteryx ephemeraeformis*) and certain pine cones. As a matter of fact, however, the article is unfortunately full of error as to the natural history of the insect, and the point of protective resemblance is not sustained when we take into account the facts regarding the habits of the species.

The common bag worm occurs on all sorts of trees. In the arboretum on the grounds of the Department of Agriculture, where many species of trees of many orders from all parts of the world are grown, hardly a species is exempt from the attacks of this insect. The bag which the larva spins is the same on every species of tree on which the insect is found; that is to say, it is the same in shape, size and general color. The bits of leaves or twigs which the insect uses to strengthen the bag with, however, will differ with the material nearest at hand, but one of these bags upon a deciduous tree will frequently look as much like a pine cone as one which occurs upon a pine tree. It is difficult to see where Mr. Weir could have gained his strikingly erroneous ideas as to the life history of the insect. He seems never to have seen the bags of the young or half grown larvæ, since he states that the

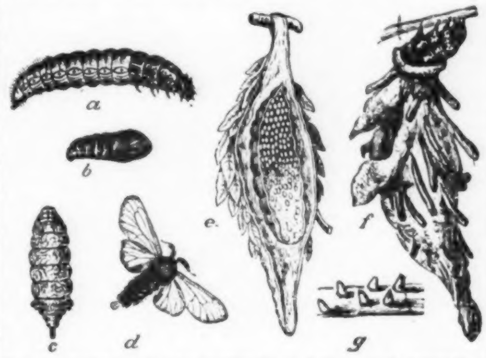


FIG. 1.—*Thyridopteryx ephemeræformis;* *a*, larva; *b*, male chrysalis; *c*, female moth; *d*, male moth; *e*, follicle and puparium cut open to show eggs; *f*, full grown larva with bag; *g*, young larvæ with their conical upright coverings; all natural size.

larva feeds upon the couch or dog grass, hiding during the day and feeding in the evening. He has probably found some cut-worm whose habits he thus describes, and assumes that this is the insect which afterward spins the bag in the pine trees. The fact is that so soon as the eggs in the old female bags hatch, and the little bag worm larvæ crawl forth into the outside world, they begin to construct bags for themselves, and these bags they carry about with them during their entire larval life, enlarging them with each moult until they fall to the ground, when they utilize them for pupation. In the SUPPLEMENT for September 28, 1878, and some weeks later, under the title of "That Fatherless and Motherless Race," I published some facts that were then new about this insect, but perhaps the following more detailed account from my later writings will prove of sufficient interest to Mr. Weir and others to justify publication.

The Eggs.—During the winter time the dependent sacs or bags of this species may be seen hanging on the twigs of almost every kind of tree. If they happen to be on coniferous trees—and they are usually more abundant on these than on deciduous trees—they are not infrequently mistaken for the cones. In reality they are the coverings spun by our worm, and they serve not only as a protection to it, but also to the eggs. Upon cutting open the larger of these bags in winter time they will be found to contain the shell of a chrysalis (technically called the puparium), which is filled with numerous small yellow eggs (Fig. 1, *e*). Each of these is a little over one millimeter in length, obovate in form, and surrounded by a delicate, fawn colored, silky down. In this condition the eggs re-

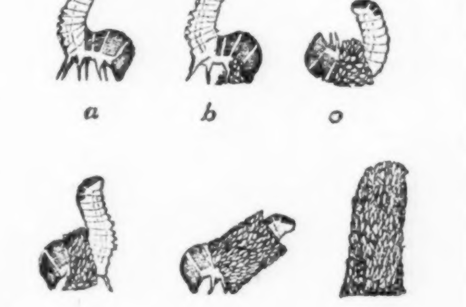


FIG. 2.—*Thyridopteryx ephemeræformis:* How the young larva prepares its bag.

main from fall throughout the winter and early spring.

The Larva and its Bag.—About the middle of May in this latitude the egg hatches into small but active larvæ, which at once commence to construct a portable case or bag in which to live. The way in which this bag is prepared is curious (Fig. 2), and has been well described by Mr. H. G. Hubbard. The young larva crawls on a leaf, and gnawing little bits from the surface, fastens these together with fine silk, produces a narrow elongate band, which is then fastened at both ends on to the surface of the leaf by silky threads. Having secured itself from falling down by some threads, it now straddles this band and, bending its head downward (Fig. 2, *b*), makes a dive under it, turns a complete somersault and lies on its back, held down by the band (Fig. 2, *c*). By a quick turning movement the larva regains its feet, the band now extending across its neck (Fig. 2, *d*). It then adds to the band at each end until the two ends meet, and they are then fastened together so as to form a kind of narrow collar which encircles the neck of the worm. Far from resting, it now busies itself by adding row after row to the anterior or lower end of the collar, which thus rapidly grows in girth and is pushed further and further over the maker (Fig. 2, *e*). The inside of this bag is now carefully lined with an additional layer of silk, and the larva now marches off, carrying the bag in an upright position (Fig. 1, *g*, and Fig. 2, *f*). When in motion or when feeding, the head and thoracic segments protrude from the lower end of the bag, the rest of the body being bent upward and held in this position by the bag. As the worms grow they continue to increase the bags from the lower end and they gradually begin to use larger pieces of leaves, or bits of twigs or any other small objects for ornamenting the outside. Thus the bags will differ according to the different kind of tree or shrub upon which the larva happens to feed; those found on coniferous trees being ornamented with the filiform pine leaves, usually arranged lengthwise on the bag, while those on the various deciduous trees are more or less densely

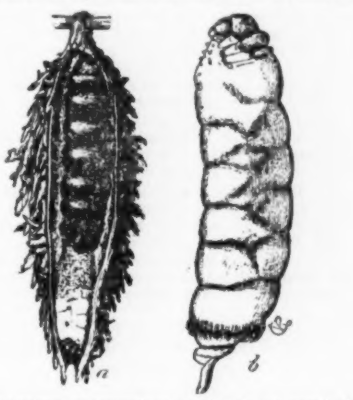


FIG. 3.—*Thyridopteryx ephemeræformis;* *a*, follicle cut open to show the manner in which the female works from her puparium and reaches the end of the bag, natural size; *b*, female extracted from her case, enlarged.

and irregularly covered with bits of leaves interspersed with pieces of twigs. When kept in captivity the worms are very fond of using bits of cork, straw, or paper, if such are offered to them. When the bags, with the growth of the larva, get large and heavy, they are no longer carried, but allowed to hang down (Fig. 1, *f*). The worms undergo four moults, and at each of these periods they close up the mouth of their bags to remain within until they have cast their skin and recovered from this effort. The old skin, as well as the excrement, is pushed out through a passage which is kept open by the worms at the extremity of the bag.

The young larva is of a nearly uniform brown color, but when more full grown that portion of the body which is covered by the bag is soft, of light brown color and reddish on the sides, while the head and thoracic joints are horny and mottled with dark brown and white (Fig. 1, *a*). The numerous hooks with which the small, fleshy prolegs on the middle and posterior part of the body are furnished enable the worm to firmly cling to the silken lining of the bag, so that it can with difficulty be pulled out.

The bag of the full grown worm (Fig. 1, *f*) is elongate-oval in shape, its outlines being more or less irregular on account of the irregularities in the ornamentation above described. The silk itself is extremely tough and with difficulty pulled asunder.

The larvæ are poor travelers during growth, and though, when in great numbers, they must often wander from one branch to another, they rarely leave the tree upon which they were born unless compelled to

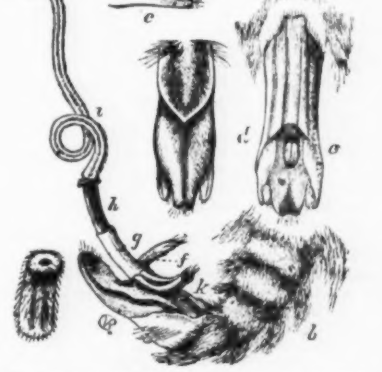


FIG. 4.—*Thyridopteryx ephemeræformis:* *b*, the end of male abdomen from the side, showing genitalia extended; *c*, genitalia inrepose, ventral view; *d*, do., dorsal view enlarged.

do so by hunger through the defoliation of the trees. When full grown, however, they develop a greater activity, especially when very numerous, and, letting themselves down by a fine silken thread, travel fast enough across sidewalks or streets and often for a considerable distance until they reach another tree, which they ascend. This migratory desire is instinctive; for should the worms remain on the same tree they would become so numerous as to necessarily perish for the want of food.

Pupation.—The bags of the worms which are to produce male moths attain rather more than an inch in length, while those which produce females attain nearly double this size. When ready to transform, the larva firmly secures the anterior end of the bags to a twig or branch, and instinct leads it to reject for this purpose any deciduous leaf or leaf stem with which it would be blown down by the winds. The inside of the bag is then strengthened with an additional lining of silk, and the change to chrysalis is made with their heads always downward. The chrysalis is of a dark brown color, that of the male (Fig. 1,

b) being only half the size of that of the female (Fig. 1, *e*, and Fig. 3, *a*).

The Imago or Perfect Insect.—After a lapse of about three weeks from pupation a still greater difference between the two sexes becomes apparent. The male chrysalis works its way to the lower end of the bag and half way out of the opening at the extremity. Then its skin bursts and the imago appears as a winged moth with a black, hairy body and glassy wings (Fig. 1, *d*). It is swift of flight, and, owing to its small size and transparent wings, is rarely observed in nature. The life duration of this sex is also very short. The female imago is naked (save a ring of pubescence around the end of the body of yellowish white color) and entirely destitute of legs and wings (Fig. 1, *c*, and Fig. 3, *b*). She pushes her way partly out of the chrysalis, her head reaching to the lower end of the bag, where, without leaving the same, she awaits the approach of the male. The manner in which the chrysalis shell is elongated and reaches to the end of the bag is shown in Fig. 3, *a*, and an enlarged side view of the female, showing the details of structure, is shown at *b* in the same figure. The extensibility of the male genitalia, which permits him to reach the female within her bag, is set forth in the accompanying Fig. 4, where the parts are shown at rest, *c* and *d*, and in action, *b*. Fertilization being accomplished, the female works her way back within the chrysalis skin and fills it with eggs, receding as she does so toward the lower end of the bag, where, having completed the work of oviposition, she forces, with a last effort, her shrunken body out of the opening, drops to the ground, and perishes. When the female has withdrawn, the slit at the head of the puparium and the elastic opening of the bag close again, and the eggs thus remain securely protected till they are ready to hatch the ensuing spring.

THE CONDOR OF THE ANDES.

By S. L. CLAYES.

AMONG the raptores, or rapacious birds, the condor holds first rank by reason of its enormous size and unparalleled voracity. It is found along the whole chain of the Andes, through Mexico, Chile, Peru and Patagonia to the Straits of Magellan, and Lewis and Clarke claim to have seen it even among the Rocky Mountains, near the source of the Missouri. But the Andes of South America is the native habitat and stronghold of these birds. They are most abundant in Chile and Peru, though even there they are not found in flocks, three or four being as many as are usually seen together. They have sometimes been called the great vultures of the Andes, and in many essential particulars they resemble the vultures of the Eastern Hemisphere.

When the bird was first seen by the Spanish conquerors of the New World, its strength and bulk so impressed them that imagination was aroused, and they likened it to the rokh of Arabian story, some even claiming it to be identical with the famous bird "which is able to trusse an elephant." Putting aside these romantic statements, even among naturalists of repute there were once the most exaggerated stories current in regard to size. Eighteen feet were gravely given by De Marchais as the actual measurement from tip to tip of the extended wings of a condor. "A width so enormous," he says, "that the bird can never enter a forest," and declares that a single one will attack a man or carry off a stag. Garcillosso states that there were some condors killed by the Spanish in Peru which measured fifteen or sixteen feet from the point of one wing to that of the other, and claims that there is a certain tribe of Indians which adores them. He adds that two will attack, overcome and devour a bull, and that a single bird will kill a boy of twelve years old. As Veillot justly says: "It was with the condor as with the Patagonians—both shrank before examination." Even Buffon exaggerated their size.

While observation has modified earlier reports, condors are still acknowledged to be the largest of known flying birds. Humboldt confesses that at first they appeared to him to be of colossal size, but says that an actual measurement corrected the illusion. He found none that exceeded nine feet in stretch of wing, and was assured by many inhabitants of Quito that they had never shot any of more than eleven feet. But this is less than the estimate of Tschudi, an accomplished zoologist and most careful and reliable authority, who in one place gives the wings an expansion of "from twelve to thirteen feet," and in another says: "I measured a very large male condor, and the width from the tip of one wing to the tip of the other was fourteen English feet and two inches, an enormous expanse of wing, not equaled by any other bird except the white albatross." But far from "trussing an elephant," Tschudi asserts that it is impossible for the condor to lift even so large a creature as a sheep from the ground, assuring his readers "he cannot when flying carry a weight exceeding eight or ten pounds." An old male condor belonging to the Zoological Society of London, which was considered a very fine specimen, measured eleven feet from tip to tip of his outstretched wings and four feet nine inches in length. Darwin, in his "Voyage of a Naturalist," writes of the first he shot: "It measured from tip to tip of the wings eight and a half feet and from beak to tail four feet."

Despite its immense size and weight the condor possesses the power of rising in its flight to a greater distance above the earth than any other bird; and Darwin speaks rapturously of its grace of motion on the wing. "When the condors are wheeling in a flock, round and round any spot, their flight is beautiful. Except when rising from the ground, I do not recollect ever to have seen one of these birds flap its wings. Near Lima I watched several for nearly half an hour without once taking off my eyes; they moved in large curves, sweeping in circles, descending and ascending, without giving a single flap. It is truly wonderful and beautiful to see so great a bird, hour after hour, without any apparent exertion, wheeling and gliding over mountain and river." Humboldt claims that it soars to an altitude of at least twenty thousand feet above the sea. From the Cave of Autisana, which is at an elevation of 12,958 feet above the Pacific Ocean, he observed a condor rise perpendicularly to a still greater height of 6,876 feet. Other authorites state that it reaches a height of six miles above the sea level, which is about six times the height of the ordinary clouds.

The bird from flying at this extreme elevation, where the air must be so highly rarefied, will drop suddenly to the valleys, thus in the briefest time passing through an almost incredible change of temperature. At such a height the air cells of the condor, when they have been filled in the lower regions, must be inflated in the most extraordinary manner. But the great bird loves the heights. They are his chosen home. Hunger alone drives him to the plains. As soon as his appetite is satiated he leaves them, appearing to be oppressed by the higher temperature and increased weight of the atmosphere, and returns to regions far above the clouds, where the air is so rarefied that a man can hardly breathe. High up as the eye can reach he may be seen describing his graceful circles against the blue. From this or even a more lofty point of vantage, he brings his telescopic eyes to bear upon the earth, eagerly scanning the movements of the herds for the fall of some weakening member of the flock. No sooner does a poor creature drop than down rush the condors to the feast.

In spite of the keenness of a hunger sharpened by one knows not how many days of watching upon the wing at that frigid altitude, our condor begins his repast daintily, tasting first the eyes and tongue, his chosen tid-bits. But soon, fired by the sight of the beautiful banquet which death has spread for him, he tears the tough hide, and, wildly pulling with his beak, pushing with his feet, and flapping his wide wings, gorges himself, gulping down great bits of flesh, and riots without stint until he can hold no more. Fairly drunken with his revolting feast, he no longer has power to raise himself upon the wing. Knowing this, the Indians will often place a dead animal as a lure upon the plains. When the birds have become gorged and unable to fly, the Indians appear and noose them with a lasso, a sport they find scarcely less exciting than the Spaniard does his bull fight.

So great is its tenacity of life that "when a condor is caught there is a fight, and a stout one, before it is killed," says an eye witness. Humboldt, who was present at the killing of one, tells that after having strangled it with a lasso the Indians hung it by the neck upon a tree, pulling vigorously upon its legs. When at length they took it down, apparently quite dead, "the bird got up and walked off as if nothing had happened. Then a pistol was fired at it, the man who fired standing within less than four paces. Three balls hit the living mark, wounding it in the neck, chest and abdomen; the bird kept its legs. A fourth ball broke its thigh. Then the condor fell to the ground, but did not die of its wounds till half an hour had elapsed."

The earlier tales of the condor's powers seem, like those of his size, to have been greatly exaggerated. Now the birds are no longer credited with particular ferocity. It is even claimed that their talons are not formidable, being too weak to seriously lacerate; that the natives do not fear them; that the little Indian children play about their parents while their fathers are engaged in collecting snow for sale in towns; that the babies with their parents sleep in safety in their near vicinity, and we have the assurance of Humboldt that he never heard one of them had been attacked or killed. He tells us, however, that two of the birds might prove dangerous if opposed to one man. Sir Francis Head's tale of the fight of a Cornish miner of his party with a condor proves that a man can conquer *one*. Still, Sir Francis reports the man to have declared that "he never had such a battle in his life; that he put his knee upon the bird's breast and tried with all his strength to twist its neck, but the condor, objecting to this, struggled violently, and as several others were flying over his head, he expected they would attack him. At last he succeeded in killing his antagonist, and with great pride showed me the large feathers from his wings; but when the third horseman came in, he told us he had found the condor in the path, but not quite dead." Darwin states on the authority of the Chileno countrymen that "the condor will live and retain its vigor between five and six weeks without eating."

The condor builds no nest, but choosing some isolated crag which towers thousands of feet above the level of the sea into the regions of perpetual snow, it there deposits two eggs upon the bare rock. The eggs are three or four inches in length and white as the purest ivory. After an incubation of about sixty days the young condor is hatched quite bare of feathers, its body being covered for several months with a whitish down, or frizzled hair, something like that which we find upon young owls. This down so exaggerates the size of the condor chick as to make it appear nearly as large as an adult. Darwin writes: "It is said that the young condors cannot fly for an entire year, and long after they are able to do so they continue to roost at night and hunt by day with their parents."

The young birds are of a brownish tint, while the general color of the mature birds is black, being brightest in the older males. This fact gave rise to a mistaken belief which was at one time current that there were two species of condors. The feathers, with the exception of the wing coverts and the secondary quill feathers, are a bright black, generally mixed with a grayish tinge. The wings are long and extremely powerful, the quill feathers measuring from two to three feet in length. The wing coverts in the females are blackish gray; in the males they are white at the points and frequently for half their length, often enabling one to thus distinguish the sexes at some distance. In both male and female the secondary quill feathers are white on the outer side. Ulloa asserts that "in the colder parts of Peru the skin is so closely covered with feathers that eight or ten balls may be heard to strike without penetrating its body." Both male and female wear about the lower part of the neck a ruff of light, downy feathers, marking the line of separation between the naked skin and the densely feathered parts below. The head and neck, wholly bare of feathers, are covered with a hard, coarse skin, deeply wrinkled and folded upon itself, of reddish-brown color, upon which some dark hairs are sparsely scattered. In the male the head is crowned with a sort of comb, firm, oblong in shape, and covered with the same rough skin as is the head. It lies along the beak, nearly to its extremity, covering the large oval nostrils, but it is so unattached at its lower end as to permit a free passage of the air for breathing. The male also bears upon its neck a loose membrane or wattle, similar to that of the turkey, and like it, capable of being dilated at the pleasure of the bird. The skin of the neck is ridged by deep parallel folds, produced by a habit which the condor has of so retracting its head when at rest as to give the impression that it has no neck. The beak of the condor is massive and strong, ash-colored and straight at its base, but sharply arched toward the point, where it terminates in a strong, well-curved hook of nearly ivory whiteness. The bluish-gray legs are extremely heavy and powerful. The toes terminate in black talons, which, though long and thick, are only slightly curved; the hinder toe, too, while somewhat more curved than the others, is wanting in strength, which renders the foot weaker in its power of grasping than that of any other bird of its order.

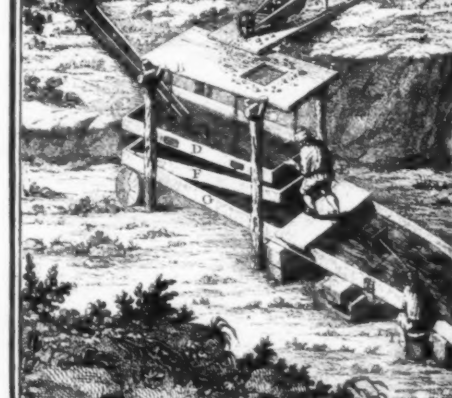
Laying aside the prejudice produced by its habits, we cannot but acknowledge that in appearance the condor, while heavier than the eagle, and less graceful in its movements when not upon the wing, is far from unattractive to the eye.—*Popular Science News.*

THE GOLD DEPOSITS OF THE PYRENEES.

IN a very interesting work entitled *Les Pyrenees*, recently published by Mr. Eugene Trutat, the author, *apropos* of the varied mining wealth of our country, calls attention to the auriferous deposits found therein. The question is of a genuine geological interest.

While, in fact, we find gold commonly in the sand derived from the Ariege, the Salat and the Garonne, and while in the extent of country comprised between Campagnac and Averdun all the ravines and brooks that empty into the Ariege are auriferous, it has hitherto always been impossible for any one to find *in situ* the rock whence the precious metal is derived. And yet this gold is far from existing in negligible quantity. In fact, according to Mr. Pailhes, an observer of the last century, there have been found between Varilhes and Pamiers spangles, or small *pepitas* rather, weighing as many as fifteen grammes.

At present, however, it seems that the deposits are greatly impoverished, so that the gold washers, formerly numerous in the country, have almost completely disappeared.



GOLD WASHERS TREATING AURIFEROUS EARTH.

A, flume leading water to the riddle; B, platform upon which the earth is deposited; C, laborer bringing the earth; D, riddle for washing the earth; E, laborer actuating the riddle; G, washing table; H, table covered with cloth on which the washing of the earth is finished; I, laborer stirring the deposit on the cloth-covered table. (From an old engraving taken from Baron Dietrich's work.)

This industry of the gold washers, as it was carried on a century ago, while it was still flourishing, was, moreover, an interesting practice.

A writer of the time, Baron Dietrich, in his curious work entitled *Description des Gîtes de Minerai, des Forges et des Salines des Pyrenees*, published in 1786, has left us some precise data upon the various methods of treatment in use among the gold washers in the county of Foix in order to obtain spangles of gold.

"The first of the methods of the gold washers of Pamiers," says he, "is the most general. The second is employed only for the very fine spangles. Yet the use of it is unfortunately very rare.

"They make use of three instruments in the first method, to wit:

"(1) A shovel called *andusa*, 9½ inches in length by 7½ in width, having the edges turned up at the sides by about four lines. This shovel serves to remove the large pebbles that cover the finest gravel as well as the sand, which the washers dig into successively until they come upon a finer part intermingled with those masses of pebbles called the *balme*. This operation produces holes upon the banks. They employ the same shovel for putting this fine gravel and this sand into the *greffane* or *gressale*.

"(2) The *greffane* or *gressale*, a sort of wooden plate of a foot and six to nine inches in diameter, hollowed out in such a way that it has a depth of about three inches in the center. It is into this plate that they put the sand and pebbles together. The largest of these pebbles scarcely exceeds an egg in size, because they throw aside with the *andusa* those that are larger.

"The plate being filled with gravel and sand, the men go barefooted to a distance of a few feet in the river or brook.

"They begin by putting their plate under the water. With one hand they stir the earth contained in the plate and draw the pebbles toward them and out of the plate, which they hold with the other hand. This too prompt operation performed in the current of the river must necessarily allow the spangles of gold, which are very small, to be carried away with the earth. After they have separated the coarser earthy portions in this way, they raise their vessel to the surface of the water and leave a portion of water in it in order to cover the sand that remains therein. They give this water a rotary motion in slightly inclining the plate toward the river, so that the lightest portions are drawn toward the edges and the heaviest collect in the center. They finally strike the river several times with the inclined part of the plate. This, again, causes the heaviest parts to deposit and the lightest ones to be carried along by the water that the motion admits into and rejects from the plate. They decant the surplus water slowly in always giving a slight rotary motion. There remains in the center of the plate a gray, black and reddish quartzy sand, strongly attracted by the magnet, and containing spangles of gold distinctly visible and of varying size. Then they allow a stream of water to enter the plate, and this causes the washed auriferous sand to flow into the *scudelle*.

"(3) The *scudelle* is a small wooden bowl of the ordinary form of bowls, and about three and a half inches in diameter, into which is poured the washed sand at each of the operations just described, and when the sand is therein the water is drained off. The humidity of this sand causes it to fix itself to the bottom, so that these people put their little bowl entirely open into their pocket without the sand escaping from it.

"The second method of collecting gold in the county of Foix requires one machine more. The one that I have seen consists of a washing plank or table five feet four inches in length by about twenty to twenty-two inches in width, provided on each of its long sides with a rim eighteen lines in height. The two extremities have no rim.

"This table is divided in the direction of its length into two unequal parts by a strip of wood about eight lines in height, the base of which is well joined to the plank. The upper part is from nineteen to twenty inches, and the lower takes up the rest of the length of the plank. I say the upper, because the plank is inclined upon a support about twenty inches in height.

"Under the strip is tacked a sort of closely woven packing cloth that extends from the strip to the lower extremity of the plank, and there is attached also to the strip, over this cloth, a small bib of coarse wool about six inches in height that occupies the entire width of the table.

"The gravel and sand are put upon the upper part with the shovel or *andusa*, and water is poured thereon with the *greffane*. The sand is stirred up successively with the hands, and the largest spangles of gold deposit upon the bib and the finest upon the cloth. In either way, there is obtained a fine, heavy, black and reddish ferruginous and quartzy sand that contains the spangles. The gold washers treat this sand with mercury, of which they afterward evaporate the amalgam."

As may be judged from this minute description by Baron Dietrich, the processes of treatment in use among the gold washers of the county of Foix were passably primitive. In spite of the imperfections of the system, it did not prevent the trade from supporting its followers, although quite meagerly. "The washers sell these spangles at 80 francs per ounce. In ordinary times they earn from 20 to 30 sols a day; and, when the water has been high, their work brings them in currently 6 francs a day. This gold is from 22 to 23 carats fine."

The quantities of gold thus extracted by the washers of the Ariege were nevertheless quite large, and, if we refer to a memoir by Mr. Pailhes, we find that the mint of Toulouse received as many as 200 marcs of gold per annum from the washers of the Ariege, the Salat and the Garonne.

Besides, states Baron Dietrich, the places of production of the gold were quite numerous in the region of the Pyrenees.

"The Ariege and the grounds in its vicinity are not the only ones of the county of Foix from which gold is derived. The collecting of it is done in still a few other places; but this work is more neglected there than in the vicinity of Pamiers. The following are the principal of these places:

"The brook of Pailhes, near the market town of that name, situated on the route from Pamiers to Mas-d'Azile, at about 6,000 toises to the west of Pamiers.

"The brook of Beouze, near Bastide-de-Seron, on the route from Foix to Saint-Girons.

"The brook of Pitron, under the *metairie* of Mazeres or Mazelles, at about 1,300 toises to the east of Bastide.

"The brook of Harize, at Durban.

"The brook of Ordas, near Durban, at 1,700 toises to the north of Castelnau-Durban, a market town, situated upon the same route, at about 4,000 toises to the west of Bastide.

"And the brook of Saint Martin.

"I have had sand washed in all these brooks, and they have all furnished me with gold. They are all in the foot hills or mountains, distinguished in the country by the name of 'mountains of earth.' These brooks traverse all the deep and pebbly ravines. Quartz and ironstone are generally found therein.

"The majority of the observations made in this memoir are also applicable to the Salat.

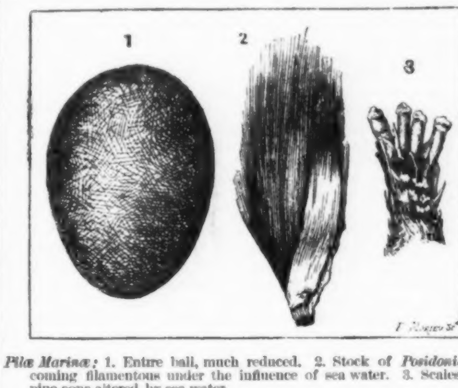
"Collecting is sometimes, but very rarely, done there on the Souex and Saint Serni side, at about 5,500 toises to the southeast of Saint Girons, in the brook of Nest, which empties into the Salat above Saint Girons, and to which the washers attribute in part the gold of the Salat. But the most ordinary work of the washers is done below Saint Girons, from Bonrepaux to Roquefort. It is principally women who occupy themselves with it in this part."

Such are the most precise data that we possess as to the exploitation, in the last century, of the auriferous deposits of our Pyrenean region.

Without being of a marked richness, these deposits, contrary to the present status of the case, fully merit being the object of a continuous exploitation.—*Les Inventions Nouvelles.*

PILÆ MARINÆ.*

IT is not rare, on the seashore, amid the debris of all kinds thrown up by the tide, to meet with certain round, depressed or ovoid masses formed of light brown, very slender filaments so entangled and closely matted that they are capable of withstanding considerable pressure without being distorted. Their size varies from that of an egg to that of a human head. What is the nature of these singular productions? A few words of history will not be out of place. Galen and Aristotle recommend the balls under consideration for scrofula, but venture no theory as to their origin. Matthiolus and Cæsalpinus consider them as sea refuse. More recently the authors who have occupied themselves with the question, and among whom may be mentioned Imperato, Draparnaud and Bory Saint-Vincent, have been divided in opinion, some



Pilæ Marinæ: 1. Entire ball, much reduced. 2. Stock of *Posidonia* becoming filamentous under the influence of sea water. 3. Scales of a pine cone altered by sea water.

holding that these objects consist merely of entangled algæ, and others regarding them as *Zosteræ* in the process of decomposition. Others, finally, have looked upon them as having an origin analogous to those balls of hair that are found in the stomach of ruminants, and that are called ægagropilæ.†

Mr. W. Russell‡ has recently resumed the study of the question, and has elucidated it in a complete manner. The differences of opinion of authors are easily explained, for from one place to another, even very close by, the origin of the balls may be very different. In the Mediterranean region we find in abundance a completely submerged plant belonging to the genus *Posidonia*. When the sea has been very rough, a certain number of the plants become a prey to the waves and soon perish. The long, flat leaves remain firmly attached to the rhizome, but their parenchyma soon disappears and leaves free long duct filaments and fibers that become entangled with each other and give rise to balls that are of a somewhat loose consistency.

In most cases, these balls are produced by pine cones. "In the course of a botanical excursion to Sainte Marguerite Island," says Mr. Russell, "I was following on the southern shore a road laid out in the center of a pine forest that extends to nearly where the tide stops, when my attention was attracted by a mass of these enigmatical balls that was so large that it constituted a true embankment around a small cove shaded by great cluster pines lashed by the waves. Upon carefully examining this deposit, I soon discovered, in addition to balls similar to those mentioned above, a number of pine cones, some of them uninjured and others appearing as if they had been raveled out and carded. Among the latter, some had undergone modifications only in their scales, which were divided into numerous filaments that were still adherent to the as yet intact axis. The pine cones thus transformed had exactly the appearance of those large brushes known by the name of badgers. In other specimens the axis had shared the same fate as its appendages, and was reduced to its ligneous skeleton to which were still fixed a few filaments, the last remains of the scales." All the phases of the disorganization of the tissues can be followed under the microscope.

Finally, in certain cases, the balls consist of algæ belonging to the genus *Cladophora*, more or less mixed with foreign bodies. Balls of this kind are frequent in the lakes of Sweden.—*La Nature.*

* I. e., "Seaballs"; French, *Pilotes de Mer;* German, *Meerpilken* or *Seeballe.*

† These ægagropilæ are produced by the hairs that ruminants swallow on licking themselves, and that accumulate in the stomach. Ancient medicine attributed wonderful properties to them.

‡ *Revue Generale de Botanique*, 1893.

CHRYSANTHEMUM JOHN NOBLE.

THIS variety is one of the many excellent English seedlings shown by Mr. Robert Owen, Maidenhead, at the meeting of the Royal Horticultural Society, held on December 12. John Noble belongs to the incurved Japanese section, and the great breadth of its florets, its large size, and bold massive appearance, contribute to make it a distinct and desirable variety. In color, it is a dull chocolate crimson, and the reverse of the florets bronzy gold. It is a good illustration of the "fancy" of the day and of the skill of the cultivator, but it is hardly to be commended from an artistic point of view.—*The Gardeners' Chronicle.*

HOW PLANTS FEED.

THE root has two offices—first, to fix the plant in the soil, and, secondly, to absorb nourishment. To this might be added that some plants also use the roots for storehouses of food on which they draw in later stages of their growth, as, for example, beets, mangels, carrots, and, indeed, most plants which live but two years. During the first year they accumulate nourishment in the root, most of which is expended in the production of seed in the second year; but this feature is not of general application. That the roots secure the plant in the soil is a self-evident truth which does not need demonstration. Nor is it necessary to prove that the roots are the medium through which the plants are nourished. The point is to know just how the food is absorbed by the roots—whether the entire root mass is engaged in this process or if it is confined to some special portions of the root, and in what condition the plant food must be in order to be available for assimilation by the roots.

It is comparatively easy to prove that plants live by drinking, rather than by eating, or, in other words, that they are fed by absorbing water which contains the necessary elements of nutrition in solution. In early times, before the science of botany was understood, some theorists believed that plants fed on small particles of soils, and that this was reason for the good results caused by thorough culture, since frequent stirring of the soil divided it into small particles, which were thus more readily swallowed and digested by the plant. This notion could, of course, not stand the light

CHRYSANTHEMUM JOHN NOBLE.

of investigation, since the roots had no mouths or openings anywhere through which even the smallest particles could pass. It was, on the other hand, evident that plants fed by some process of absorption, since a withered plant might be revived by merely putting its roots in cold water.

This is further proved by immersing the young, active roots of a plant in water in which some coloring material has been dissolved. The roots absorb the color, which shows itself throughout the tissue. Now, does this absorption take place through the ends of the roots or through the whole length of the root? Investigation has proved that it does neither the one nor the other. The tips of the roots, as has already been stated, consist of a compact mass of small, hardened cells, which are designed to pierce the soil when the root is elongated by growth. These cells are not suited for absorption. Nor do the older portions of the root, on which the outer covering has become thickened and leathery, take a prominent part in feeding the plant. This is proved by the fact that a plant having the older portions of the roots immersed in water, while the young growth is kept in the air, will wither almost as fast as if the plant was wholly exposed to the air.

The absorption of plant food must, therefore, take place wholly, or at least chiefly, through the young and tender portions of the root. A close examination further reveals the fact that the young growth of the roots is more or less covered with very fine fibrous appendages which have been called root hairs. These hairs are slender tubes, with very thin walls, and they constitute the real absorbing surface of the roots.

Many of these root hairs are so small that they cannot be seen with the aid of a microscope. They are simply projections of the outer cells of the root, just as the fingers project from a glove—that is, they do not have a partition at the base, but open directly into the cells. As the root grows older, this outer layer of cells becomes thickened and the root hairs disappear, and the cells lose absorbing power in proportion. This explains why the older portions of the roots, covered with a thickened epidermis or sort of bark, have but slight absorbing powers. At the close of the season of growth, when plant food is no longer in demand for the development of new tissue above ground, absorption ceases and the root hairs die. Even the newer portions of the root become covered with epidermis, and the plant becomes dormant until warm weather the following spring renews its vitality.

But how can this absorption occur? What is the reason that the newly formed tender cells of the roots, when they come in direct contact with the moisture in the soil, absorb this moisture, or, in other words, what force causes the moisture to enter the cells? The cause is a natural phenomenon which has not been satisfactorily explained. It is due to the force technically called "osmose," or diffusion of liquids through a membrane, and is defined as a "kind of molecular attraction allied to that of adhesion." This force is exhibited when two liquids of different densities are separated from each other by a thin animal or vegetable membrane. The two liquids then tend to mix or become diffused by passing through this membrane. Thus experimenters have proved that when a bladder is filled with brine and then immersed in a vessel of water, the water will pass through the bladder and cause it to become more distended, and even to force its contents to rise in a tube attached to the neck of the bladder, and at the same time the brine in the bladder will pass through the membrane and give a salt taste to the water. Now the absorption of water by the tender cell tissues takes place on the same principle.

The moisture in the soil in which the roots are bathed passes through the thin cell walls and rises in the tissues of the plant. That the absorptive power which this force gives rise to is very great, at least in some plants, is readily proved by direct observation. Everybody is familiar with the fact that maple sugar is made from the sap of a certain species of maple tree. This sap is obtained by boring a hole in the tree through which it exudes in great quantities. Fruit growers are familiar with the fact that when a grape vine is pruned late in the spring, after the roots begin absorption, it "bleeds" freely from the wounds. The same may be seen in stumps of trees cut down early in the season and in many other cases. Such cases give abundant proof that the sap which flows from the wound so freely must be replaced by the liquid absorbed by the roots.

That the roots feed on the soil, as the common expression goes, is really not correct. They feed on water contained in the soil which holds certain substances in solution. What these substances are we shall see in a later paper. The presence or absence in the soil of these food materials makes the difference between a fertile and a sterile soil. The fertile lowlands along rivers and streams are fertile because they contain an abundance of this food material, and hilltops and barren sands lack fertility because the elements of plant food are present in but small amount. Now, the root growth depends largely upon the fertility of the soil. It has been observed that when roots reach a fertile spot they develop an enormous amount of feeders, that is, small tender rootlets, which can absorb this nourishment.

Any one can readily convince himself of this by noticing how enormously roots multiply in spots in the soil where a small mass of manure has been plowed under. It is frequently found to be penetrated through and through with a thread-like network of the fine white roots, while in the soil immediately surrounding such spot the roots may be but sparsely distributed. It has even been noted that when there are successive layers of fertility in the soil the roots will develop in these layers in the manner stated, whereas in the less fertile soil intervening there are but few roots to be found. It is for these reasons that in a fertile soil the roots do not usually reach so far, but are more uniformly distributed through the whole mass of the soil than is the case when the soil is less fertile. In poor, sandy soil, it is claimed that corn roots have been traced for a length of fifteen feet from the plant. Call it instinct or what we may, they seem to have the power to search for food, and when found they make the most of it by producing an abundance of absorbing surface. In like manner the roots of some plants apparently go in search of water. When the soil can be penetrated, alfalfa roots will thus grow to a great depth until the water table is reached, and it is a common observation that the roots of willows or other trees will follow a drain or sewer for long distances until an opening is found through which the water percolates, and entering this they will fill the drain, sometimes for many yards, with a mass of roots almost as solid as if it had been clamped in place.—*Prof. C. C. Georgeson, in Kansas Farmer.*

COMPARATIVE VALUE OF MANURES FOR POTATOES.

THE importance of this subject is so great to the country that any facts bearing on the possible increase of the crop by ordinary means should be frequently brought before the public, for facts are of much more value than flights of fancy. Land is of such variety in composition, and manures produce such different results on different lands, that it is desirable to carry out experiments in as many districts as possible to test manures which have given good results in other places.

There are a great number of allotments in this district, and for the benefit of the holders and the district generally a committee was formed to carry out some experiments for testing certain manures for potato culture. Potatoes are extensively grown here, and some who have grown large quantities for many years and have observed the effects of different manures and the quantity of each constituent to be applied per acre with benefit, are now able to grow 10 and 11 tons per acre, and that not in the best land, the land costing 1*l.* 10*s.* per acre. One large grower told me he would apply more manure if he found it of benefit, but there is a limit in the amount of a crop, and the manure applied to produce it is a serious item. The largest crop at the least cost should be the aim of all cultivators, but this cannot be attained without long experience and careful observation in testing various compositions. With this object in view, experiments were carried out last summer. The idea was to obtain some of the poorest land to prove more clearly the value of the manure.

The land itself without manure produced about 6 tons 3 cwt. per acre. This was from several perches of land. Three varieties of potatoes were tested—Maincrop, Imperator and Schoolmaster. The last named was planted because it is usually much diseased, and it was intended to apply the remedy for disease in July, but this was not done. We had from two to four perches of land for each of the compositions planted with Maincrop potatoes, and this variety gave the best results. Fifty-four square perches were set out carefully in an open field. The chemical manures were weighed in correct proportion per acre, and each square numbered on a regular plan. The manures were all applied when planting at the end of April, with one exception, the nitrate of soda, half of which was put on when the moulding was done in June. This turned out to be the best of all.

The land was not plowed deep enough, the soil being quite hard a few inches from the surface, and when this was discovered operations could not be canceled. This I consider was much against the experiments. All the men recognized the want of depth, and many spoke disparingly of the work, yet many of the squares produced from 140 to 173 lb. of potatoes. We had seven rows in the perch, 16 feet 6 inches wide, and the potatoes about 15 inches apart in the row. The preparation of this land is what I should call bad farming, and there is little doubt that much land is not cultivated deep enough for this crop. I am aware that much land used for potatoes cannot be deeply cultivated, but there is much that could be, and it would pay for doing, even supposing only half of an acre could be plowed in a day. The following shows the manure used and the results obtained:

Farmyard or fold manure, 4 cwt. per perch, or 32 tons per acre, at 5*s.* per ton, would cost 8*l.* per acre. This produced an average of 120 lb. per perch; in round numbers this would be at the rate of 8 tons 11½ cwt. per acre.

Farmyard manure at the rate of 2 cwt. per perch, or 16 tons per acre, with superphosphate, kainit, and nitrate of soda in equal quantities, 4½ lb. per perch, or 6 cwt. chemicals per acre, produced on an average 138 lb. per perch, or 9 tons 17 cwt. per acre. Cost of manure 6*l.* 5*s.*

Chemical manure: Kainit, superphosphate, and nitrate of soda, 3 lb. of each per perch, or about 12 cwt. per acre, all applied at the time of planting, cost £3 per acre. This produced 142 lb. per perch, or over 10 tons per acre. The same manure, with this exception, that half the nitrate of soda was applied in June when the moulding was done, produced on an average 156 lb. of tubers per perch. This would be more than 11 tons per acre. The latter proportion of manures produced the best results at Warminster last year, and should be tried everywhere.

Six pounds per perch, or 8 cwt. per acre, consisting of 1½ parts superphosphate, 1 nitrate potash, 1 gypsum, cost £2 12*s.* per acre, and produced an average of 140 lb. per perch, or 10 tons per acre. This is very good for such a cheap manure.

Six pounds per perch, of a mixture of 5 parts kainit, 4 nitrate soda, and 2 gypsum, cost £1 19*s.* per acre, and produced an average of 138 lb. of good tubers per perch.

Six pounds per perch, containing equal parts superphosphate, kainit, and sulphate of ammonia, cost £2 10*s.* 8*d.* per acre, and produced an average of 128½ lb. per perch.

Nine pounds per perch, consisting of 3 lb. superphosphate, 6 lb. kainit, produced 144 lb. per perch, at a cost of £1 8*s.* per acre.

Six pounds of manure per perch, containing 4 parts superphosphate, 3 nitrate of potash, 1 nitrate of soda, and 2 gypsum, cost at the rate of £3 per acre, and produced on an average 130½ lb. per perch.

Five and seven-eighths pounds per perch, consisting of 3 parts basic phosphate, 5 nitrate of potash, 6 gypsum, and costing 2*l.* 10*s.* 2*d.* per acre, produced an average of 117 lb. per perch.

Six pounds per perch, containing 2 lb. superphosphate, 3 lb. kainit and 1 lb. nitrate of soda, costing 1*l.* 9*s.* 4*d.* per acre, gave 144 lb. produce per perch.

Two and a quarter pounds of Ichaboe guano, per perch, at 1*l.* 17*s.* 6*d.* per acre, seemed useless.

Small potatoes were from 4 to 16 lb. per perch. The largest quantities, which were more than double of some of the least, had not half so many small ones, thus showing that good manure is profitable in every way. The chemical manures, which gave the best results, showed the good effect of the manure from the first, when the shaws were only a foot high. This was on the next section to that where no manure had been given, and every potato showed a marked difference. The Maincrop potato is of a splendid quality from suitable land, and is now the leading kind grown for the market. It is worth 10*s.* per ton more than the Bruce, but a ton per acre extra can be grown of the latter; it has yielded 11 tons to the acre this season in this district.—*George Harris, in The Gardeners' Magazine.*

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